HOUSEHOLD ENERGY SAVINGS: OPTIONS FOR THE FUTURE

Brian D. Sumner
and Barbara F. Green

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Preface

This study is the result of research conducted by both Barbara E. Green and Brian D. Sumner over a period of approximately two years. Chapters 1 to 3 were written by Barbara Green, while the final chapter and the appendices were completed by Brian Sumner. Many others contributed to the study.

The authors would like to thank, in particular, Charles Slagorsky for his helpful comments, Mark Brown for his research assistance and typists Shirley Ingstrup, Janice Tener and Arlene Ward for their considerable patience.

EXECUTIVE SUMMARY

As the price of various energy forms used by Canadian households rises, it makes increasing economic sense to invest in measures which will reduce energy consumption. These measures may include added thermal insulation, more energy efficient household appliances, or conversion to a method of home heating that is expected to cost less in the future.

This is a study of the options available to homeowners to reduce their energy bills. Three types of dwellings in twelve different cities across Canada are considered, given stated levels of thermal insulation and airtightness, and forecast fuel prices for each city.

The first three chapters are concerned with identifying and comparing household energy costs in twelve urban centres (Victoria, Vancouver, Calgary, Edmonton, Regina, Winnipeg, Toronto, Ottawa, Montreal, Saint John, St. John's and Halifax). These comparisons show that household energy bills vary greatly across the country and through time due to variations in climatic conditions, types of home heating energy available and energy prices.

In Chapter 4 the authors identify a variety of ways by which household energy bills may be reduced through conservation measures or fuel substitution. The analytical framework within which the savings and payback periods are calculated is outlined. Then, results are presented showing the dollar value of saving from reducing energy consumption in each of the twelve cities. In this way, both the benefits and costs of household energy conservation and substitution are examined. Using the analytical framework provided, each homeowner can calculate his or her costs, benefits and payback period, based on specific information about a particular home with respect to locale, energy prices, government grants and subsidies. The differences in costs and benefits between work done by a contractor or the homeowner himself are also highlighted.

The analysis reported here indicates that substantial monetary benefits can be derived from most of the energy-saving options discussed. If energy costs continue to increase in real terms, the economics of implementing such measures will become very attractive.

Chapter 1

INTRODUCTION AND KEY ASSUMPTIONS

1.1 Introduction

Canada is fortunate in possessing large reserves of natural resources including crude oil, natural gas and hydro-electricity. However, the supply of these energy sources is not inexhaustible. Recent energy price increases and economic fluctuations have led Canadians to respond by attempting to curtail the direct use of energy in their homes.

The pattern of energy use established by Canadian households in the previous twenty years has changed significantly. The rate of growth of residential energy consumption, an average annual rate of 3.8 percent during the 1960s, has declined to an average annual rate of 2.2 percent since 1970.[1] In 1960, residential energy use approximated 24.5 percent of total domestic consumption, but this figure had declined to 19.3 percent by 1979.[2]

Many factors have contributed to the gradual reduction of the rate of growth of residential energy consumption in the last decade, but it is difficult to demonstrate a cause-and-effect relationship between prices, demographic trends, and other economic fluctuations on the one hand, and energy consumption statistics on the other. However, most observers tend to agree that the price of energy, particularly dramatic changes in price, have had a significant impact on residential energy consumption. Figure 1.1 substantiates this, depicting rapid growth in energy use in the 1960s accompanying the decline of real energy prices. Similarly, the growth slowdown of the 1970s concurs with an average annual increase in real prices of 6.1 percent for oil, 3.9 percent for natural gas, and 2.5 percent for electricity.[3]

Viewing these price changes for the last decade in another way, national average annual fuel bills for space and water heating (in 1981 dollars) for fuel oil, natural gas, and electricity rose by 65 percent, 37 percent, and 23 percent respectively. In current dollars, these increases have been far more dramatic. The sharp fluctuations in residential energy consumption, beginning in 1973, and subsequent price

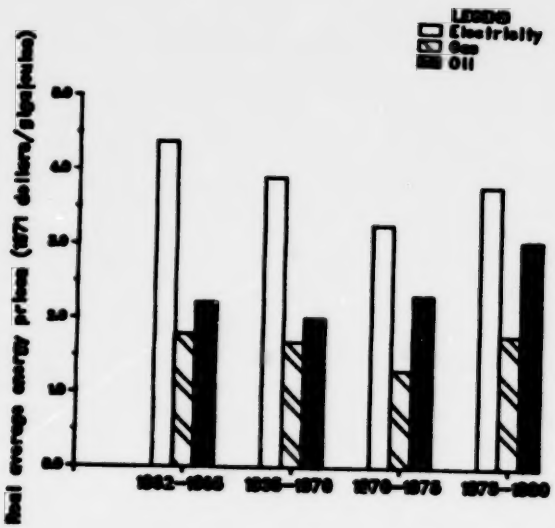


FIGURE 1.1: Trends in Average Real Energy Prices, 1962–1980 (1971 dollars)

increases can probably be attributed to a number of significant events: first, the OPEC oil embargo of 1974 which resulted in oil prices increasing from $3.84/bbl in 1973 to approximately $40.00/bbl in 1981, and second, the continuing national bout with 'stag-flation' or combined recession and double-digit inflation.

Demographic contributions to reductions in residential energy use can be assessed by focusing on consumption statistics at the individual household level. According to Figure 1.2, between 1960 and 1970, energy consumption grew rapidly in each household--that is, total residential energy use grew faster than either population or household formation. More specifically, while residential energy consumption grew by 3.8 percent annually, population increased at a rate of only 1.8 percent annually, and the number of households rose by only 2.7 percent annually.[4] This rapid increase in individual household energy consumption can be largely attributed to three factors: (1) an increase in size of the average Canadian home; (2) the trend toward saturation in major energy consuming home appliances such as clothes dryers and dishwashers[5]; and (3) increased energy intensiveness in such appliances as frost-free refrigerators.

This trend toward higher per household energy consumption was halted around 1970, with total energy use per household declining throughout the subsequent decade. Demographic trends are instrumental in explaining this reversal, for as population growth slowed to an average annual increase of 1.2 percent, household formation was increasing at an average rate of 3.7 percent per annum throughout the seventies.[6] At the same time, the average number of persons per household declined from 3.9 to 3.0 in 1976.[7] The high rate of household formation combined with smaller household size was a direct consequence of the 'coming-of-age' of baby-boom children and, to a lesser extent, higher divorce rates, greater longevity, and the increasing tendency of older people to live alone. Figure 1.3 shows the changing level of energy consumption per household from 1960-1982.

Smaller households typically tend to use less energy. However, each additional household adds more energy consumption to the total than would the same number of individuals if they lived in a combined larger household, for each new addition means supplementary space and water heating equipment and appliances. Thus, while energy use per household was seen to decline throughout the seventies, total residential energy consumption increased, although at a declining rate.

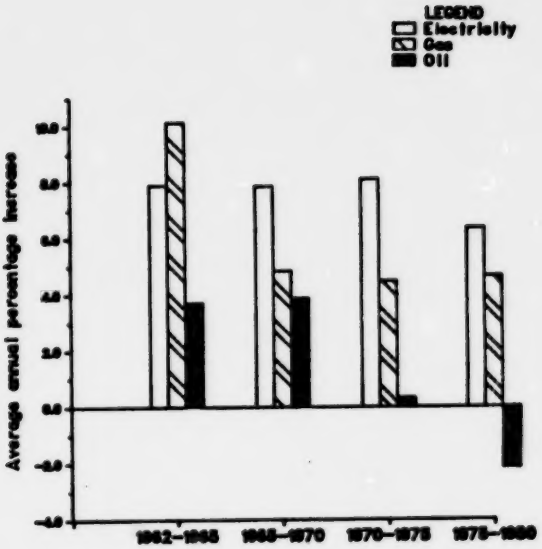
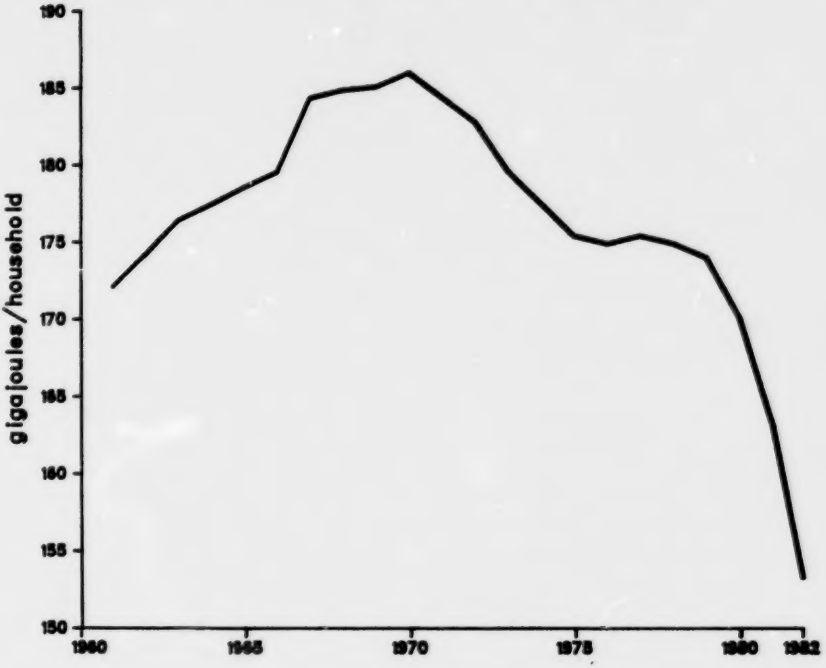


FIGURE 1.2: Average Annual Growth Rates in Residential Energy Demand, 1962–1980



Source: Statistics Canada, Catalog No. 57-003, 57-207, 91-517.

Figure 1.3: Energy Consumption per Household, in Canada 1960-1982

It would appear, therefore, that many factors have contributed to a reduced rate of growth in Canadian energy consumption over the last decade. Most significant is the dramatic increase in fuel costs over the very low costs of the 1960s and early 1970s, which has graphically demonstrated to Canadians that reducing household energy consumption is a profitable investment. The speed of the response to date suggests that actions taken by residents to reduce consumption are primarily attributable to changes in energy consumption habits (e.g., turning back the thermostat) and retrofit of existing dwellings (e.g., increased insulation levels). A longer time frame is normally required to bring about widespread replacement or improvement of capital stock, including heating equipment and housing units.

As previously indicated, motivation to invest in such basic conservation measures stems largely from a desire to save money and resist rising energy prices, however, residents are frequently unable to identify those changes which are optimal for their home and lifestyle. Reducing household energy requirements is not, to a point, technically difficult, but it is greatly influenced by the attitudes, choices, and behavior of the occupants, within a range circumscribed by the limitations of the structure itself. In addition, diverse climatic conditions, wide variations in construction techniques, and differing degrees of home maintenance make it difficult to make broad and general statements about potential energy and cost savings to Canadian homeowners interested in implementing any one or a number of upgrading options. Rather, it is necessary to inspect individual homes and arrive at conclusions based on facts unique to each particular dwelling and situation if specific energy and cost savings conclusions are desired. Broad payback priorities are not too hard to establish.

The main objective of this study, therefore, is to outline those options which are the most viable and economical for the individual homeowner given the following factors: (1) type of dwelling; (2) city in which the dwelling is located; (3) current levels of insulation and air-tightness; and (4) forecast fuel price increases in each city. To facilitate this analysis, the study examines three hypothetical housing types--a single-detached unit, a semi-detached unit or duplex, and a rowhouse--in twelve Canadian cities representing diverse climatic regions. The cities are as follows: Victoria, Vancouver, Calgary, Edmonton, Regina, Winnipeg, Toronto, Ottawa, Montreal, Saint John, St. John's, and Halifax.

The selected dwelling types are drawn from a sample of eleven homes which were investigated by Canada Mortgage and Housing Corporation for changes in energy consumption patterns under various retrofit schemes, as published in the CMHC's 1977 document The Conservation of Energy in Housing. The three were chosen because it was felt they were representative, given their size and structure, of a significant portion of the housing stock in all twelve Canadian cities and because they were all of comparable size (1060 to 1100 square feet). Table 1.1 provides a general description of each dwelling type with more specific detail on individual building components such as walls, attic, foundation, etc.

1.2 Study Organization

This study is composed of four chapters. Chapter 2 provides a comparative analysis of Canadian household energy costs and its respective components--including space heating, water heating and appliance operation--for the years 1980 and 1990. This analysis is conducted for each hypothetical dwelling in all twelve Canadian cities. In Chapter 3 appliance energy use is discussed from the perspective of both current and future potential to conserve energy through redesign and modification with current and future technology.

In Chapter 4 the potential to reduce energy costs through a variety of currently feasible conservation and substitution options will be investigated for the three hypothetical dwellings mentioned above and for all twelve cities in the sample. For purposes of this analysis, the options are categorized into the following three general classifications: (1) basic conservation measures; (2) upgrading of existing insulation levels; and (3) conversion to an alternate fuel. Chapter 4 also contains a discussion of the overall conclusions of the analysis, both for individual cities and for specific dwelling types. An attempt is made to ascertain those measures which are most viable and economical and are likely to provide the greatest savings to those homeowners who desire to lower household energy costs but are unable to identify those changes which are optimal for their home and lifestyle.

1.3 Energy Pricing Assumptions

Estimates of costs which appear in Chapters 2 and 3 are based upon real or constant dollar rate structures and prices which existed in the various cities at the time of writing. However, in order to

TABLE 1.1

GENERAL DESCRIPTION OF HYPOTHETICAL DWELLINGS

Single Detached:		
Livable floor area	$100m^2$	
Net exposed wall area	$81m^2$	
Attic area	$100m^2$	
Foundation perimeter	40m	
Window area	$13m^2$	
Door area	$4m^2$	
Semi-Detached:		
Livable floor area	$102m^2$	
Net exposed wall area	$90m^2$	
Attic area	$51m^2$	
Foundation perimeter	22m	(not shared)
Window area	$13m^2$	
Door area	$4m^2$	
Rowhouse (internal unit):		
Livable floor area	$98m^2$	
Net exposed wall area	$59m^2$	
Attic area	$49m^2$	
Foundation perimeter	14m	(not shared)
Window area	$10m^2$	
Door area	$4m^2$	

SOURCE: Canada Mortgage and Housing Corporation, The Conservation of Energy in Housing, Ottawa: CMHC, 1977, pp. 68, 71, and 73.

estimate the relative benefit resulting from making various investments in conservation or substitution options, the future relative movements of fuel oil, natural gas and electricity prices must be estimated. Rapid developments in domestic and international energy markets and changing government policies can make forecasting, especially over a ten year period, hazardous. However, for the purposes of Chapter 4, forecasts of residential energy prices were required. These are average provincial prices and are presented in Appendix A.

Footnotes

[1]Statistics Canada Catalog 57-003, 1960-1980.

[2]Energy, Mines and Resources Canada, IFSD model database, January 1981.

[3]Ibid.

[4]Statistics Canada Catalogue 93-702, Households by Size, Volume II - Part 1, May 1973.

[5]Statistics Canada Catalogue 57-003, Household Facilities and Equipment, May 1980.

[6]Statistics Canada Catalogue 93-805, Private Households by Size, May 1979.

[7]Ibid.

Chapter 2

METHODOLOGY FOR CALCULATION OF TOTAL HOUSEHOLD ENERGY REQUIREMENTS AND COSTS

As briefly stated in the previous chapter, diverse climatic conditions, wide variations in construction techniques, differing degrees of home maintenance, and highly varied attitudes and behavioral patterns of dwelling occupants, all make it difficult to make broad and general statements about household energy requirements and costs in Canada. Rather, it is usually necessary to examine individual homes and arrive at conclusions based on those factors unique to each particular dwelling and its occupants.

A typical household energy bill basically consists of three separate components--space heating, water heating, and appliance operation (the latter includes lighting). Thus, using a hypothetical single detached home in Ottawa as a sample case, this chapter provides a discussion of the methodology and assumptions employed in quantifying these three variables and determining their respective influence on the magnitude and composition of a total annual household energy bill.

The first section provides basic information about the causes and effects of dwelling heat loss and gain, the methodology employed in estimating or measuring this transfer of heat, and the procedure for translating this phenomenon into dwelling space heating requirements, for a typical heating season. The second section consists of a discussion of the procedure for estimating water heating requirements, while the third section contains an assessment of energy requirements for appliance operation for a 'typical' Canadian household. In conclusion, the fourth and final section fulfills one of the two main objectives of the study--derivation of a total annual energy bill for each of the three hypothetical dwellings in twelve Canadian cities--based on the methodology and assumptions presented in the first part of this chapter.

2.1 Calculation of Energy Requirements for Space Heating

2.1.1 The Nature of Heat Flow in Housing

Heat flows through a dwelling's thermal envelope mainly by two separate and unique processes--conduction through building materials and convection within or across air spaces. The rate of heat transfer within a dwelling is a function of internal/external temperature differentials, of thermal gradients (i.e., insulation), and of time. This transfer of heat is always from warm to cold, so that during the winter or heating months, the flow of heat is always from indoors to outdoors, while during the summer months the reverse may be true. Heat flow can be slowed, but never stopped, by the addition of insulation or some other material equally resistant to heat transfer; this in turn reduces fuel consumption by decreasing the amount of heat the heating plant must provide in order to maintain a constant indoor temperature.

Conductive Heat Loss

The heat flow characteristics of a component of the building envelope (ie., wall, attic, foundation, etc.) is referred to as its conductance and can be defined as the transfer of heat energy through or within a solid. The conductance value is expressed as the rate of heat flow in British Thermal Units[1] (BTU) per square foot of area, per hour, subject to an indoor/outdoor temperature differential of one degree Fahrenheit. This is often stated as BTU/(ft^2°F) for some specific thickness. For the sake of simplicity, however, the heat transmission rate is often just referred to as 'U'. Thus the higher the conductance value, the greater is the heat loss from the building component or the enclosed space. The metric equivalent of this measure is watts per square metre degree Celsius W/(M^2°C).

A building material's resistance to heat flow, or R-value, is a measure of its insulating properties and is simply the reciprocal of its conductance value (U). This type of relationship is called an inverse proportion and is expressed simply as:

$$U = 1/R \text{ or } R = 1/U$$

Correspondingly, the written expression of R is also the inverse of U--namely, ft^2°F/BTU--and contrary to the conductance rate, the higher the thermal resistance of a building component (and similarly of any

insulating material), the lower is the rate of heat loss. The metric equivalent of this is RSI = M^2°C/W.

Table 2.1 demonstrates the previously discussed principles of conductance and resistance for a cross-section of exterior wall. In this particular example, even the air film at each side of the wall has a slight insulating ability.

Convective Heat Loss

The second major cause of heat loss is the direct movement of warm air from the interior of the dwelling to the exterior through openings and cracks in the thermal envelope. This is known as convective heat loss and can be defined as the transportation of heat energy by the movement of the fluid material (in this case air) that contains it. It has traditionally been a source of thermal inefficiency in both old and new construction, accounting for approximately 20 to 40 percent of all heat transfer through the building envelope.

The underlying cause of convective heat loss, or air infiltration as it is frequently referred to, is a difference in the pressure between inside and outside air induced by wind, temperature differences, or mechanical ventilation. When air pressure increases either inside or outside it seeks relief through the path of least resistance, thus air leakage may occur at doors, windows, chimney flues, and all wall openings such as light switches, vents, and pipe and wire entrances. Construction quality and general condition of a house influence the level of infiltration. It is, therefore, normal for infiltration to increase as a dwelling ages with gradual shrinkage, settling, and wear.

It has been estimated that for every degree Fahrenheit of temperature differential between the indoor and outdoor air, each cubic foot of heated air exchanged causes a loss of 0.018 BTU of heat energy.[2] Thus, air infiltration or convective heat loss is usually evaluated and measured in terms of air changes per hour (ACPH). This simply means the number of times in a given hour that the 'total' volume of air in a dwelling is replaced by cooler outdoor air. The rate of air change increases whenever the wind speed or indoor/outdoor temperature differential increases, and may vary from near zero on a calm spring day to several air changes per hour on a windy winter day. A review of the literature indicates that the average infiltration rate for most moderately insulated and sealed houses is approximately 1.0

TABLE 2.1

TOTAL THERMAL RESISTANCE (R_t) AND CONDUCTANCE(U_t) FOR A CROSS-SECTION OF EXTERIOR WALL

Building Material	R-value	U-value
Outside air film	0.17	
Siding: wood, 1/2 inch by 8 inches, lapped	0.81	
Sheathing: plywood, 1/2 inch	0.62	
Insulation: 3 1/2 inches fibreglass batt	11.00	
Interior finish: gypsum board, 1/2 inch	0.45	
Inside air film:	0.68	
Total resistance (R_t)	13.73	
Total conductance (U_t)		0.0728

SOURCE: Housing and Urban Development Association of Canada (HUDAC), Builder's Guide to Energy Efficiency in New Housing, January 1980, Appendix A.

TABLE 2.2

AIR LEAKAGE TEST RESULTS FOR AN AVERAGE HOME

Component	Percentage of Total Convective Heat Loss
Sillplate (cracks between foundation and walls)	25
Electrical outlets	20
Duct system	14
Exterior windows	12
Exterior doors	5
Range vent	5
Fireplace (damper closed)	5
Dryer vent	3
Sliding glass door	2
Other	9
Total	100

SOURCE: Congress of the United States, Office of Technology Assessment, Residential Energy Conservation, Volume 1, p. 230.

ACPH, while poorly sealed dwellings can range as high as 3.0 ACPH.[3] An average figure for typical well-built new houses appears to be 0.5-0.7 ACPH.[4] A reading of 0.5 ACPH represents a safe lower limit below which humidity and air quality problems tend to appear unless mechanical ventilation has been introduced.

The aggregate percentage breakdown of convective heat loss is illustrated in Table 2.2. It clearly indicates that approximately half of all air infiltration occurs through electrical outlets and cracks between the foundation and walls (sillplate), with a surprisingly small contribution from windows and doors--12 and 5 percent, respectively. Mechanical ventilation from clothes dryers and range vents contributes an additional 7 percent by drawing conditioned air out of the house, which simultaneously decreases the inside pressure and pulls cooler outdoor air in through all available openings. An additional 5 percent of all convective heat loss can be attributed to closed fireplace dampers. Of even greater significance, however, is the fact that an open damper in an idle fireplace chimney can completely empty a home of its warm indoor air every hour, doubling the normal infiltration rate; and if there is a fire burning, this rate can even triple.

It should be noted that a certain amount of air infiltration is required within each dwelling, not only to avoid air quality problems and excessive humidity levels, but also to provide a continuous supply of oxygen to such features as flame appliances, furnaces, and fireplaces. Combustion air requirements can be met by ducts directly to the appliance over and above this level. However, such air requirements are only a fraction of the total air leaking into a typical home. In fact, excess infiltration represents unnecessary and costly heat loss, especially in those homes where owners have taken steps to reduce conductive heat loss by upgrading insulation levels.

2.1.2 Calculation of Annual Heat Loss for a Hypothetical Dwelling

Total heat loss from a typical dwelling can be attributed to five basic areas: the foundation or exposed floor, exterior walls, roof or ceiling, windows and doors, and air change. The Department of Energy, Mines, and Resources Canada in their 1976 publication, Keeping the Heat In, attempted to quantify that portion of total heat loss which is attributable to each of these five sources, given the time period of construction of the dwelling (see Table 2.3). However, these figures are strictly approximations based on averages for all of

TABLE 2.3

PORTION OF TOTAL HEAT LOSS ATTRIBUTABLE TO PARTICULAR PARTS OF THE HOUSE

Housing Type	Source of Heat Loss	Percentage of Total Heat Loss (range of possible values)
Houses Built Before 1945:	Air Change	25 - 40
Ceiling-R7-10	Ceiling	5 - 15
Walls-R4-6	Walls	20 - 40
Basement-No insulation	Basement	10 - 20
	Doors & windows:	
	- single glazing	20 - 25
	- double glazing	8 - 15
Houses Built 1946-1950:	Air Change	30 - 40
Ceiling-R6-11	Ceiling	5 - 20
Walls-R5-11	Walls	15 - 30
Basement-No insulation	Basement	10 - 25
	Doors & windows:	
	- single glazing	20 - 25
	- double glazing	10 - 15
Houses Built 1951-1960:	Air Change	25 - 35
Ceiling-R11	Ceiling	10 - 15
Walls-R6-10	Walls	10 - 25
Basement-No insulation	Basement	20 - 30
	Doors & windows:	
	single glazing	25
	double glazing	15 - 20
Houses Built 1961-1975	Air Change	20 - 30
Ceiling-R11	Ceiling	10 - 15
Walls - R10	Walls	10 - 20
Basement-No insulation	Basement	20 - 25+
	Doors & windows:	
	- single glazing	25
	- double glazing	15 - 20

SOURCE: Energy, Mines and Resources Canada, Keeping the Heat In, August 1976, pp. 35-36.

Canada. If a greater degree of accuracy is desired, it is necessary to inspect individual homes taking into account such factors as: (1) climate; (2) type of dwelling; (3) current levels of insulation; (4) occupancy characteristics, etc.

Using a hypothetical single-detached dwelling in Ottawa as a sample case, this section contains a review of the methodology employed in estimating heat loss for a single dwelling over a typical heating season. The methodology is adapted from a procedure developed and utilized for similar purposes by Canada Mortgage and Housing Corporation (CMHC) in their 1977 publication, The Conservation of Energy in Housing.[5]

The estimation of annual dwelling heat loss was conducted assuming first a 'low' level of insulation, and then correspondingly, a 'minimum' or 'moderate' level, both of which are provided in greater detail in Table 2.4 The former reflects levels considered representative of much of the housing stock constructed after 1950[6], while the latter is based on standards of thermal resistance for new buildings published in the 1977 National Building Code.[7] Historically, higher costs of electric heating, as opposed to heating with oil or gas, have correspondingly facilitated slightly higher standards of thermal resistance for electrically heated homes in Canada. This phenomenon will be reflected in all subsequent analyses conducted in this chapter and throughout the remainder of the study. Knowing that conductance is a function of area stated in terms of one square foot, it is possible to derive the total conductance (U_t) of larger or smaller areas simply by multiplying the conductance factor (U) per square foot by the total area. More specifically, if estimating the total conductance of a window, it would mean summing the conductances of both the glass and the frame, while similarly the total conductance of a dwelling would refer to the sum of the conductances of all the building components which comprise that home.

Thus, for the hypothetical single-detached home in Ottawa, the conductance factor per unit area of each building component was multiplied by the total area of each component (except below grade foundation),[8] and then summed across components to derive the total dwelling conductance factor. Adding total heat loss from air convection resulted in a complete dwelling heat loss factor (G). This procedure was conducted independently for both the low and minimum levels of insulation and, in the latter case, assuming first electric heating and then natural gas or oil heating (to reflect fuel specific

TABLE 2.4

GENERAL DESCRIPTION OF INSULATION LEVELS
FOR HYPOTHETICAL DWELLINGS

	Low Level of Insulation		Minimum Level of Insulation
Ceiling:	Roofing Rafter Ceiling joist R-10 insulation Gypsum lath Plaster	Ceiling:	Roofing Rafter Ceiling joist R-13 insulation (oil, gas, electric)/ R-14 insulation Gypsum lath Plaster
Exterior Walls:	Exterior cladding (wood, brick, or stucco) Lumber sheathing R-10 insulation Gypsum lath Plaster	Exterior Walls:	Exterior cladding (wood, brick or stucco) Lumber sheathing R-13 insulation (oil, gas, electric)/ R-14 insulation Gypsum lath Plaster
Basement:	1 ft. concrete foundation above grade 7 ft. concrete foundation below grade No insulation	Basement:	1 ft. concrete foundation above grade 7 ft. concrete foundation below grade No insulation
Windows:	Single glazed/no storms	Windows:	Double glazed or storm windows
Doors:	Solid 1 3/4" wood door/no storms	Doors:	Solid 1 3/4" wood door and weather-stripping/no storms
Air Change:	2.0-3.0 air changes per hour	Air Change:	1.0 air change per hour

SOURCES: Canada Mortgage and Housing Corporation, The Conservation of Energy in Housing, 1977, p. 68; and National Research Council of Canada, Residential Standards, National Building Code, issued by the Associate Committee on the National Building Code, Ottawa, 1977, pp. 15-19.

standards of thermal resistance under the 1977 National Building Code).

The complete dwelling heat loss factor (G) is expressed in BTU per degree hour.[9] Therefore, multiplying 'G' by 24 (hours per day) provides the building heat loss per degree day and further multiplication by 8429 (which is the number of degree days (DD)[10] for Ottawa) results in the estimated total heat loss in BTU for a typical heating season. Referring to specific estimated values for heat loss factors it is possible to derive annual heat loss for the hypothetical single-detached dwelling in Ottawa. More specifically,

Total heat loss (BTU) = 24 x G x DD

Therefore;

1) Assuming a low level of insulation:
   Total heat loss (BTU) = 24 x 825 x 8429
   = 166,894,200 (176 gigajoules)

2) Assuming a minimum level of insulation:
   (a) Electrically heated:
   Total heat loss (BTU) = 24 x 419 x 8429
   = 84,762,024 (89.39 gigajoules)

   (b) Non-electrically heated:
   Total heat loss (BTU) = 24 x 428 x 8429
   = 86,582,688 (91.31 gigajoules)

It should be stressed that these estimates are conservative as they account for only that heat loss directly attributable to the conductive and convective characteristics of the building envelope, not to the living habits of the dwelling occupants (ie., failure to close fireplace dampers, windows, doors, etc.).

2.1.3 Calculation of Annual Space Heating Requirements for a Hypothetical Dwelling

To maintain a constant desired indoor temperature, heat must be introduced into the dwelling at the same rate as heat is being dissipated through the processes of conduction and convection. However, knowing the total heat loss for a dwelling--in this case, 84.8 to 166.9 million BTU--does not necessarily provide an accurate assessment of the actual demands which may be placed on the heating system.

The first factor to consider is that some of the dissipated heat is replaced from other sources. For instance, normal functions of everyday living, such as appliance operation, lighting, and heating of hot water provide sources of internal heat gain to a dwelling. Solar radiation or sunshine, when absorbed by objects within a home, is re-emitted as heat radiation. Solar gain, however, is difficult to factor accurately into the heating load reduction of a dwelling because such variables as sunshine hours, wind direction, outside air temperature, and directional orientation of windows all have an impact on the net gain from solar heat. Individual occupants themselves can contribute approximately 300-350 BTU per hour of body heat, translating into 1,800,000 BTU (1.9 gigajoules) over a heating season.[11] In short, internal gains go on throughout the heating season, but their contribution to reduced space heating bills varies for each dwelling according to its design, construction, and occupancy characteristics.

Regardless of individual differences, it is still possible to estimate dwelling space heating requirements by factoring out heat from incidental sources. Canada Mortgage and Housing Corporation alleges that in uninsulated or poorly insulated homes, total heat loss is so high that internal heat gains constitute a very small proportion of the total heat replaced--approximately 10 percent.[12] At the other extreme, in very highly insulated dwellings, incidental heat sources contribute a much larger proportion of the total heat energy requirements, nearly 25 percent. It was assumed for purposes of this chapter only, however, that the dwelling in question was typical of most homes built between 1950 and 1980 and that incidental heat sources contribute, on average, approximately 15 percent of the total heating load. Thus, for the hypothetical single-detached dwelling in Ottawa, estimates of heating requirements, factoring out internal heat gains, would be as follows:

1) Assuming a low level of insulation:

Space heating requirements (BTU) = 0.85 (24 x G x DD)
= 0.85 (166,894,200)
= 141,860,070
(149.6 gigajoules)

2) Assuming a minimum level of insulation:
   a) Electrically heated:
      Space heating requirements (BTU) = 0.85 (24 x G x DD)
                                       = 0.85 (84,762,200)
                                       = 72,047,720
                                         (75.98 gigajoules)

   b) Non-electrically heated:
      Space heating requirements (BTU) = 0.85 (24 x G x DD)
                                       = 0.85 (86,582,688)
                                       = 73,595,285
                                         (77.61 gigajoules)

The second factor to be considered is that total space heating requirements for a specific dwelling is a direct function of the combustion or conversion efficiency of the fuel being burned. Most residential buildings in Canada are heated with fuel-fired heating systems which are dependent on fossil fuels (mainly oil and gas), as shown in Table 2.5. Considerable controversy arises over the typical operating efficiencies of these systems, two reasons being that remarkably little is known about their performance in actual operating environments, and the fact that the literature in the area is replete with inconsistent information.

Performance undoubtedly varies with the type of unit, its age, size, installation, position in the building, maintenance, and a number of other variables. Until recently, the most common value quoted was the 'steady-state' or 'full-load' combustion efficiency, which refers to the fraction of energy available from the fuel (if burned under ideal conditions) which is actually delivered by the furnace when it is properly adjusted and all parts of the system have reached operating temperature. Thus, it is usually expressed as the ratio of useful heat delivered to the furnace bonnet divided by the heat energy released in burning a unit of fuel. However, this definition does not give a complete measure of the fuel required to heat a living space over the heating season because as actual home installations are seldom in perfect adjustment. A definition which does, and one that is increasingly being used, is the seasonal performance factor or seasonal efficiency. This measure is defined as the ratio of useful heat delivered to the furnace bonnet divided by the heating content of the fuel used by the furnace over the entire heating season--the latter being the product of the heat energy released in burning a unit of fuel and the estimated efficiency of delivery of useful heat. Thus, seasonal efficiency accounts for all factors affecting the heating system's performance in its actual operating environment. This includes heated stack-gases

TABLE 2.5

PERCENTAGE OF TOTAL CANADIAN HOUSEHOLDS USING SPECIFIED FUELS FOR SPACE HEATING

City	Fuel for Space Heating		
	Oil	Gas	Electricity
Victoria	70.6	n/a	27.9
Vancouver	18.4	72.9	8.6
Calgary	n/a	98.9	n/a
Edmonton	n/a	98.9	n/a
Regina[a]	27.3	66.1	2.0
Winnipeg	8.7	72.0	18.6
Toronto	37.2	53.8	8.8
Ottawa	61.9	21.8	16.1
Montreal	63.4	11.5	25.0
Saint John[a]	76.5	n/a	16.5
St. John's	69.1	n/a	26.6
Halifax	91.4	n/a	8.2

SOURCE: Statistics Canada, Household Facilities and Equipment, Catalog 64-202 Annual, May 1979.

[a]Based on provincial estimates

lost during combustion, loss of heated air through the chimney while the furnace is off, heat losses through the air distribution ducts when in unheated spaces, and cycling losses. The latter is the result of operation at part loads which causes heat to be lost by raising the temperature of the furnace before useful heat can be delivered to the living space. Most existing homes have furnaces oversized by at least 50 percent, so they are always operating at relatively inefficient part-load conditions.[13] The oversizing may be greater still in homes that have had insulation, storm windows, or other thermal envelope improvements added since the furnace was installed.

Electric resistance heaters radiate heat directly into a room from baseboard, floor, or ceiling coils, or sometimes heat is distributed from an electric furnace similar to a fuel-fired system. If used to operate a boiler or furnace, electricity is basically the same as fossil fuels, except that no chimney is required; hence, there is no loss of heat in the form of combustion gases and direct air flow to the exterior of the dwelling. As a result, electric resistance heaters require little maintenance and usually function very efficiently.

Considering a hypothical single-detached home in Ottawa, it is now possible to estimate annual heat energy requirements by type of fuel being burned. Assuming a heating system dependent on fuel oil, it has been determined that one gallon of fuel oil generates 166,600 BTU (175.69 megajoules) of heat energy, but that the seasonal efficiency is probably no greater than 60 percent.[14] Therefore, annual space heating requirements, in gallons of fuel oil, can be determined by:

$$\text{Annual heating requirement} \over 166{,}600 \times 0.6$$

Previously it was determined that the annual heating load (or the amount of useful delivered heat), taking into account internal heat gain, was approximately 141.9 and 73.6 million BTU (149.65 and 77.62 gigajoules) assuming a low and minimum level of insulation, respectively. Thus, annual space heating requirements can be determined as follows:

1) Assuming a low level of insulation:

$$\frac{141{,}860{,}000}{166{,}600 \times 0.6} = 1419 \text{ gal. (6450.77 litres)}$$

2) Assuming a minimum level of insulation:

$$\frac{73,595,285}{166,600 \times 0.6} = 736 \text{ gal. (3345.86 litres)}$$

Similarly, results can be obtained for natural gas-fired systems where the heating content of the fuel is 1,030,000 BTU (1086.71 megajoules) per Mcf but the seasonal efficiency is only approximately 70 percent.[15]

1) Assuming a low level of insulation:

$$\frac{141,860,070}{1,030,000 \times 0.7} = 197 \text{ Mcf (5580.50 cubic meters)}$$

2) Assuming a minimum level of insulation:

$$\frac{73,595,285}{1,030,000 \times 0.7} = 102 \text{ Mcf (2889.35 cubic meters)}$$

Assuming that electric resistance heaters are 100 percent efficient,[16] the measure of electricity required to heat a living space over the heating season, is derived simply by taking the ratio of the heating load divided by the heat energy released in burning a unit of fuel--in this case 3412 BTU (3.6 megajoules) per kW.h. Heating load was previously approximated to be 141.9 and 72.0 million BTU (149 and 75.9 gigajoules), assuming a low and minimum level of insulation, respectively. Therefore:

1) Assuming a low level of insulation:

$$\frac{141,860,070}{3412} = 41\,577 \text{ kW.h}$$

2) Assuming a minimum level of insulation:

$$\frac{72,047,720}{3412} = 21\,116 \text{ kW.h}$$

Application of the methodology discussed in this section to each of three hypothetical dwellings in all twelve cities in the analysis provided the results presented in Table 2.6.

2.2 Calculation of Energy Requirements for Water Heating

The water heating system is the second largest utilization of energy in the home, basically because it operates almost constantly while most other household appliances are used intermittently. In Canada, domestic hot water is supplied almost exclusively by automatic, storage-type water heaters using electricity, gas, or fuel oil as an

TABLE 2.6

ANNUAL SPACE HEATING REQUIREMENTS FOR
THREE HYPOTHETICAL DWELLINGS

City	Level of Insulation	Single Detached			Semi-Detached			Rowhouse		
		Oil (litres)	Gas (m^3)	Elect. (kW.h)	Oil (litres)	Gas (m^3)	Elect. (kW.h)	Oil (litres)	Gas (m^3)	Elect. (kW.h)
Victoria	Low	4250.51	n/a	27391	3441.32	n/a	22182	2754.87	n/a	18430
	Minimum	2627.51		16051	2282.09		14212	1818.04		11414
Vancouver	Low	4159.59	3597.64	26779	3368.57	2917.76	21688	2695.78	2322.88	17350
	Minimum	2573.04	2237.90	15694	2232.09	1926.29	13896	1777.48	1529.70	11159
Calgary	Low	n/a	6402.09	n/a	n/a	5183.99	n/a	n/a	4135.86	n/a
	Minimum		3201.04			2719.47			2237.89	
Edmonton	Low	n/a	6657.04	n/a	n/a	5813.99	n/a	n/a	4334.15	n/a
	Minimum		3399.34			2861.11			2322.88	
Regina	Low	8164.62	7053.63	52632	6614.43	5722.22	42624	5291.54	4560.78	34099
	Minimum	4118.68	3540.98	25691	3514.06	3031.07	22640	2859.44	2492.84	18325
Winnipeg	Low	8123.70	7025.30	52356	6582.61	5693.89	42400	5264.26	4532.45	33920
	Minimum	4100.50	7540.98	25557	3500.42	3002.75	22521	2845.79	2436.19	18229
Toronto	Low	5637.04	4872.39	36321	4564.18	3937.56	29415	3650.44	3172.71	23532
	Minimum	2923.08	2549.50	17748	2486.67	2124.58	15869	2022.98	1756.33	12841
Ottawa	Low	6450.72	5580.58	41577	5223.35	4504.13	33660	4182.32	3625.96	26928
	Minimum	3345.86	2889.44	21116	2845.80	2436.19	18158	2318.46	2011.27	14694
Montreal	Low	6032.54	5212.32	38885	4886.95	4249.18	31491	3909.56	3399.34	25192
	Minimum	3132.19	2691.14	19463	2663.96	2294.55	16988	2172.99	1869.63	13748
Saint John	Low	7059.94	n/a	42435	2332.46	n/a	34366	4268.69	n/a	27493
	Minimum	3414.04		21219	2904.89		18540	2368.47		15003
St. John's	Low	6632.61	n/a	42725	5368.83	n/a	34602	4291.42	n/a	27682
	Minimum	3868.65		24134	3354.95		21480	2809.43		17920
Halifax	Low	5696.14	n/a	36681	4609.64	n/a	29707	3691.35	n/a	23765
	Minimum	3318.58		20720	2882.16		18441	2413.93		15384

energy source (See Table 2.7). Such water heaters perform two basic functions in supplying hot water: (1) they heat the incoming cold water; and (2) they store the heated water until it is delivered to the outlets. Thermal losses from the tank, water lines, and water outlets occur in each of these processes and add substantially to the energy requirements for water heating.

Water heating costs can be considered a function of three factors: (1) the amount of hot water used; (2) the temperature setting on the water heater; and (3) heat loss from the hot water system. Since water flows at a rate of approximately 0.5 gallons per minute in a 0.5 inch water line at a water pressure of 60 pounds per square inch, the volume of hot water consumed is a direct function of time (i.e., the longer the hot water tap remains on, the greater the amount of water utilized). As hot water is removed from the tank it is replaced by cold water, thus lowering the overall temperature of the water in the tank. Most electric hot water tanks are set at 165° F in the factory, therefore when the temperature falls below that level, the thermostat mechanism is activated and energy is used to heat the water to the desired temperature setting.

It has been estimated that a typical family of four uses approximately 50 gallons of hot water per day or 18,250 gallons per year.[17]

If it takes one BTU of energy to raise the temperature of one pound of water one degree Fahrenheit, and a gallon of water weighs ten pounds, ten BTU of heat energy are required to raise the temperature of one gallon of water by one degree Fahrenheit. The temperature on the inlet side of a hot water tank is very close to ground temperature--approximately 55° F (although this will vary with locale). Therefore, raising the temperature of one gallon of water from 55° F to 165° F--a temperature difference of 105° F--would require (105 x 10) or 1050 BTU of heat energy. An annual usage of 18,250 gallons would, therefore, require (18,250 x 1050) or 19,162,500 BTU (20.2 gigajoules) per year. After allowing for tank losses and line losses in the amount of 3,772,000 BTU (3.98 gigajoules),[18] this figure would more closely approximate 23,000,000 BTU (24.2 gigajoules). This estimate does not take into account the efficiency of the hot water heating exchanger, which, because of carbon buildup, may decrease to 60 percent for fuel oil and 70 percent for natural gas.[19] Mineral deposits on electric heaters in electric hot water tanks may lower their efficiencies slightly, but for this analysis, electric heaters are assumed to be 100

TABLE 2.7

PERCENTAGE OF TOTAL CANADIAN HOUSEHOLDS USING SPECIFIED FUELS FOR WATER HEATING

City	Fuel for Water Heating		
	Oil	Gas	Electricity
Victoria	29.8	n/a	65.1
Vancouver	18.4	72.9	8.6
Calgary	n/a	96.6	2.9
Edmonton	n/a	97.4	2.4
Regina[a]	n/a	64.2	33.0
Winnipeg	n/a	61.7	36.6
Toronto	9.7	51.7	38.0
Ottawa	16.5	18.5	64.3
Montreal	20.4	11.2	67.8
Saint John[a]	37.2	n/a	58.6
St. John's	16.4	n/a	83.6
Halifax	65.3	n/a	33.1

SOURCE: Statistics Canada, Household Facilities and Equipment, Catalog 64-202 Annual, May 1979.

[a]Based on provincial estimates.

percent efficient. Total heat energy requirements for hot water heating are derived by dividing total fuel requirements by the product of the heat energy released in burning a unit of a particular fuel and the efficiency of that fuel in delivery of useful heat. More specifically:

$$\text{Fuel Oil} = \frac{23{,}000{,}000}{166{,}600 \times 0.6} = 230 \text{ gal. (1045.58 litres)}$$

$$\text{Natural gas} = \frac{23{,}000{,}000}{1.030{,}000 \times 0.7} = 32 \text{ Mcf (906.49 cubic metres)}$$

$$\text{Electricity} = \frac{23{,}000{,}000}{3412 \times 1.0} = 6740 \text{ kW.h}$$

These estimates are standard for each dwelling type in all twelve cities included in the analysis.

2.2.1 Calculation of Annual Energy Requirements for Appliance Operation for a Hypothetical Dwelling

Household appliances may be classified generally into two categories: major appliances such as ranges, refrigerators, freezers, dishwashers, and clothes washers and dryers; and small portable appliances such as televisions, stereos, vacuum cleaners, etc. The majority of these are powered by electricity, although some of the units which consume large amounts of energy (such as ranges and clothes dryers) may be powered by gas.

For purposes of this analysis, however, a sample of electric appliances, exclusively, was selected which were considered representative of those found in many Canadian households. Table 2.8 provides not only a listing of the specified appliances, but also their respective kilowatt-hour consumption and estimated cost of annual operation. Prices have been established to reflect the range in 1981 electricity costs among the twelve cities in the analysis.

It is evident from the table that a 'typical' Canadian household can be expected to consume approximately 7300 kW.h of electricity for appliance operation in any given year. This figure, although strictly an estimate, is used to represent appliance energy consumption in each hypothetical dwelling unit in each of the twelve cities.

TABLE 2.8

ESTIMATED kW.h OF USE AND ANNUAL ENERGY COST
FOR COMMON HOUSEHOLD APPLIANCES IN 1981
(1981 dollars)

Appliance	Annual kW.h/year Consumption[a]	Annual Operating Cost[b]	
		2.6¢/kW.h	5.2¢/kW
Refrigerator-freezer (frost-free)	1800	46.80	91.80
Electric range (standard)	1200	31.20	61.20
Freezer (15 cubic feet) (frost-free)	1585	41.21	80.84
Clothes washer (automatic)	96	2.50	4.90
Clothes dryer	960	24.96	48.96
Total	5641	146.67	287.70
Television (colour)	600	15.60	30.60
Stereo (solid state)	72	1.87	3.67
Vacuum cleaner	48	1.25	2.45
Sewing machine	12	.31	.61
Kettle	205	5.33	10.46
Iron	50	1.30	2.55
Toaster	36	.94	1.84
Shaver	12	.31	.61
Hair Dryer	36	.94	.84
Total	1647	42.83	84.01
Total Annual Consumption and Operating Costs	7288	189.53	371.71

[a]Canada Mortgage and Housing Corporation, The Conservation of Energy in Housing, pp. 127-128.

[b]Electricity prices reflect the range in costs between 12 cities in the analysis.

2.3 Calculation of Total Annual Household Energy Bill

The previous sections of the chapter involved assessment of the nature and magnitude of the components of total household energy consumption--space heating, water heating, and appliance operation-- for a hypothetical single-detached dwelling in Ottawa. Where requisite, the methodology was also applied to each of three hypothetical dwellings--in a single-detached, a semi-detached, and a rowhouse--for all twelve cities in the analysis. This information is now aggregated and translated into a total annual household energy bill in order to provide a basis for comparison of household energy costs across the selected dwelling types and cities for 1980 and 1990.

The analysis was based on actual energy rate structures in place in each city throughout 1980. Tables 2.9 to 2.11 provide a sampling of the methodology employed in deriving a total annual household energy bill for each of three residential heating fuels for a hypothetical single-detached dwelling in Ottawa. As is evident from the tables, electricity and gas costs operate on a declining block rate structure while oil is simply a fixed unit cost. Therefore, in the case of the first two fuels, the initial units of purchased energy will prove to be the most costly.

Table 2.12 shows the results of the work accomplished using the methodology presented in this chapter. This table provides estimates of total annual household bills for the three different types of housing in all twelve cities for 1980 (in 1981 dollars). Table 2.13 provides estimates of household bills in the year 1990 (also expressed in 1981 dollars).

In order to facilitate comparison, 1980 household energy consumption and costs have been disaggregated by component for a single-detached dwelling[20] assuming a 'minimum' level of insulation, and presented in Figures 2.1, 2.2, 2.3 and 2.4. The graphs were designed to reveal the respective magnitudes of fuel costs in relation to actual consumption for each main component of the analysis. Thus, it is readily apparent where the greatest potential for energy conservation exists.

TABLE 2.9

ESTIMATION OF TOTAL HOUSEHOLD ENERGY BILL FOR SINGLE DETACHED DWELLING IN OTTAWA WITH OIL SPACE AND WATER HEATING

	Fuel	Estimated Consumption	Energy Rate Structure	Cost	
				$1980	$1981
Appliance operation	Electricity (kW.h)	7300	First 50 kW.h @ 5.5¢/kW.h Next 200 kW.h @ 2.9¢/kW.h All additional kW.h @ 2.085¢/kW.h	220.60	239.68
Water heating	Fuel Oil (#2)	230	$0.838 per gallon	192.74	209.41
Space heating	Fuel Oil (#2)				
	- low level of insulation	1419	$0.838 per gallon	1189.12	1291.98
	- minimum level of insulation	736		616.77	670.12
TOTAL ANNUAL ENERGY BILL					
- low level of insulation					1741.07
- minimum level of insulation					1119.21

TABLE 2.10

ESTIMATION OF TOTAL HOUSEHOLD ENERGY BILL FOR SINGLE DETACHED DWELLING IN OTTAWA WITH GAS SPACE AND WATER HEATING

	Fuel	Estimated Consumption	Energy Rate Structure	Cost	
				$1980	$1981
Appliance operation	Electricity (kW.h)	7300	First 50 kW.h @ 5.5¢/kW.h Next 200 kW.h @ 2.9¢/kW.h All additional kW.h @ 2.085¢/kW.h	220.60	239.68
Water heating	Natural Gas (Mcf)	32	First 0.4 Mcf $3.42 (minimum bill) Next 0.6 Mcf @ $4.093/Mcf Next 2 Mcf @ $3.729/Mcf Next 3 Mcf @ $3,469/Mcf All over 6 Mcf @ $3.368/Mcf	111.31	120.94
Space heating	Natural Gas (Mcf) - low level of insulation	197	All over 6 Mcf @ $3.368/Mcf	663.50	720.89
	- minimum level of insulation	102		343.54	373.26
TOTAL ANNUAL ENERGY BILL - low level of insulation - minimum level of insulation					1081.51 733.88

TABLE 2.11

ESTIMATION OF TOTAL HOUSEHOLD ENERGY BILL FOR SINGLE DETACHED DWELLING IN OTTAWA WITH ELECTRIC SPACE AND WATER HEATING

	Fuel	Estimated Consumption	Energy Rate Structure	Cost	
				$1980	$1981
Appliance operation	Electricity (kW.h)	7300	First 50 kW.h @ 5.5¢/kW.h Next 200 kW.h @ 2.9¢/kW.h All additional kW.h @ 2.085¢/kW.h	220.60	239.68
Water heating	Electricity (kW.h)	6740	All Additional kW.h @ 2.085¢/kW.h	192.09	208.64
Space heating	Electricity (kW.h)				
	- low level of insulation	41,577	All additional kW.h @ 2.085¢/kW.h	1184.94	1369.79
	- minimum level of insulation	21,116	All additional kW.h @ 2.085¢/kW.h	601.81	695.69
TOTAL ANNUAL ENERGY BILL					
- low level of insulation					1818.11
- minimum level of insulation					1144.01

TABLE 2.12

TOTAL HOUSEHOLD ENERGY BILLS FOR THREE HYPOTHETICAL DWELLINGS IN 1980
(1981 dollars)

	Victoria	Vancouver	Calgary	Edmonton	Regina	Winnipeg	Toronto	Ottawa	Montreal	Saint John	St. John's	Halifax
Single-Detached												
Low												
Oil	1504	1470	n/a	n/a	2107	2190	1671	1741	1808	2252	2202	2144
Gas	n/a	881	685	695	883	1236	1107	1082	1227	n/a	n/a	n/a
Electricity	1355	1337	n/a	n/a	2077	1366	1231	1818	1496	2279	2137	2777
Moderate												
Oil	1131	1111	n/a	n/a	1268	1295	1063	1119	1144	1430	1542	1614
Gas	n/a	747	510	543	613	613	774	734	340	n/a	n/a	n/a
Electricity	1013	1002	n/a	n/a	1188	1050	1010	1144	962	1470	1476	1949
Semi-detached												
Low												
Oil	1318	1291	n/a	n/a	1796	1847	1431	1671	1545	1863	1901	1902
Gas	n/a	814	618	637	781	1075	973	1118	1079	n/a	n/a	n/a
Electricity	1198	1183	n/a	n/a	1747	1490	1406	1617	1292	1972	1847	2416
Moderate												
Oil	1052	1034	n/a	n/a	1135	1165	965	1126	1036	1315	1420	1517
Gas	n/a	717	481	520	574	751	713	822	779	n/a	n/a	n/a
Electricity	957	948	n/a	n/a	1087	974	947	1090	894	1367	1382	1831
Row-house												
Low												
Oil	1161	1139	n/a	n/a	1537	1554	1226	1432	1322	1622	1643	1697
Gas	n/a	756	560	587	691	934	863	882	948	n/a	n/a	n/a
Electricity	1084	1052	n/a	n/a	1466	1269	1206	1388	1119	1709	1602	2107
Moderate												
Oil	945	931	n/a	n/a	987	1016	862	1005	924	1194	1290	1412
Gas	n/a	678	462	497	532	679	660	761	713	n/a	n/a	n/a
Electricity	873	865	n/a	n/a	945	869	844	972	804	1232	1255	1672

TABLE 2.13

TOTAL HOUSEHOLD ENERGY BILLS FOR THREE HYPOTHETICAL DWELLINGS IN 1990
(1981 dollars)

	Victoria	Vancouver	Calgary	Edmonton	Regina	Winnipeg	Toronto	Ottawa	Montreal	Saint John	St. John's	Halifax
Single-Detached												
Low												
Oil	2404	2148	n/a	n/a	3716	3576	2774	2891	2737	3633	3701	3464
Gas	n/a	1476	1293	1320	1637	1920	1844	1728	1604	n/a	n/a	n/a
Electricity	1682	1511	n/a	n/a	3212	1584	1742	2218	1828	3451	3526	3596
Moderate												
Oil	1793	1548	n/a	n/a	2123	2040	1735	1908	1611	2235	2587	2543
Gas	n/a	1225	970	975	1083	1212	1251	1249	1026	n/a	n/a	n/a
Electricity	1129	1117	n/a	n/a	1679	1242	1453	1471	962	2194	2425	2557
Semi-detached												
Low												
Oil	2097	1842	n/a	n/a	3040	2983	2272	2635	2286	2971	3191	3039
Gas	n/a	1325	1164	1194	1425	1449	1519	1525	1393	n/a	n/a	n/a
Electricity	1512	1335	n/a	n/a	2435	1414	1598	1753	1306	2973	3050	3145
Moderate												
Oil	1661	1419	n/a	n/a	1896	1815	1487	1726	1434	2039	2380	2371
Gas	n/a	1157	909	920	1002	1028	1072	1128	929	n/a	n/a	n/a
Electricity	1067	1039	n/a	n/a	1545	1059	1333	1365	900	2034	2283	2411
Row-house												
Low												
Oil	1678	1496	n/a	n/a	2330	2190	1861	1983	1675	2442	2530	2338
Gas	n/a	1376	1120	1097	1279	1395	1429	1408	1209	n/a	n/a	n/a
Electricity	1464	1316	n/a	n/a	2021	1355	1479	1592	1128	2711	2860	2792
Moderate												
Oil	1419	1172	n/a	n/a	1486	1378	1299	1345	1183	1778	1980	1915
Gas	n/a	1077	852	860	970	963	977	1081	897	n/a	n/a	n/a
Electricity	1004	989	n/a	n/a	1320	975	1216	1248	833	1906	2176	2160

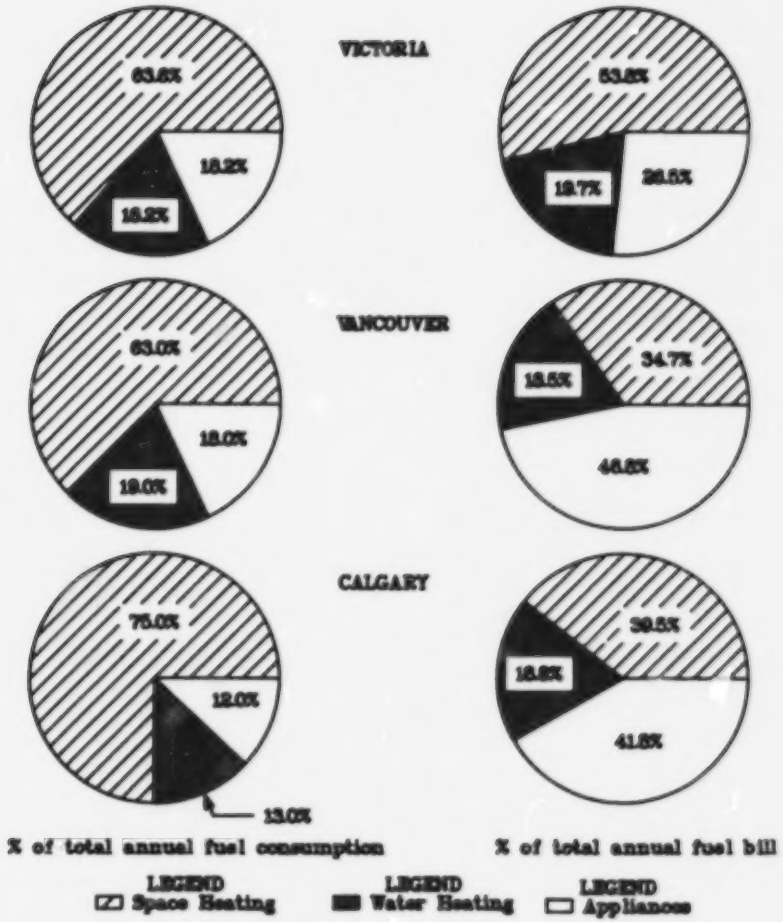


Figure 2.1: Disaggregated Household Energy Consumption and Costs for Selected Canadian Cities, 1980

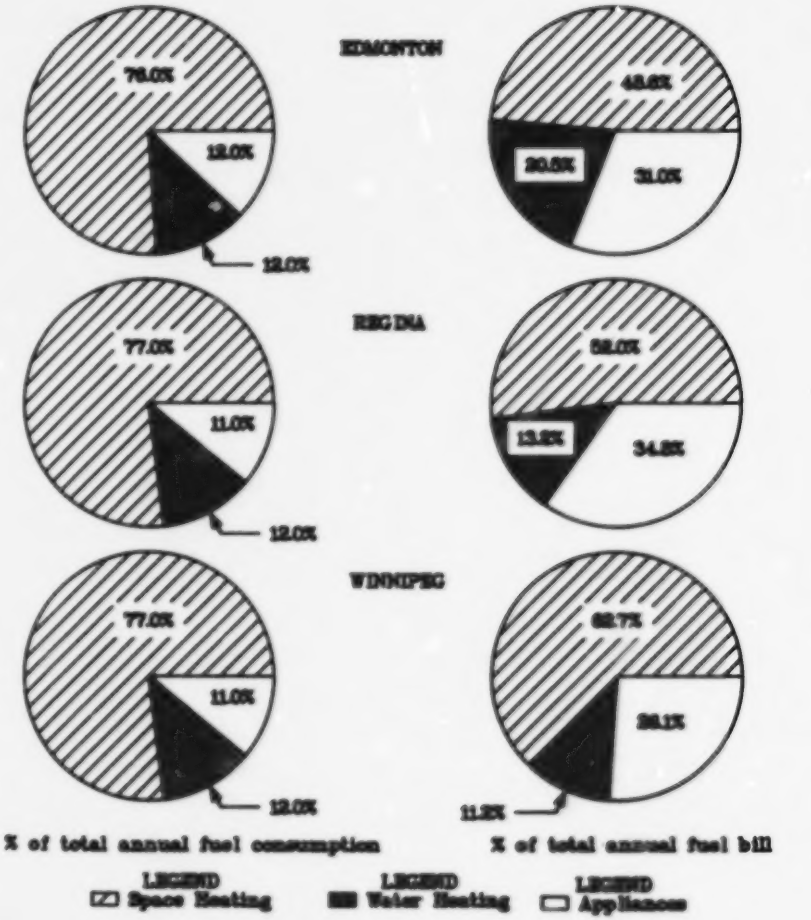


Figure 2.2: Disaggregated Household Energy Consumption and Costs for Selected Canadian Cities, 1980

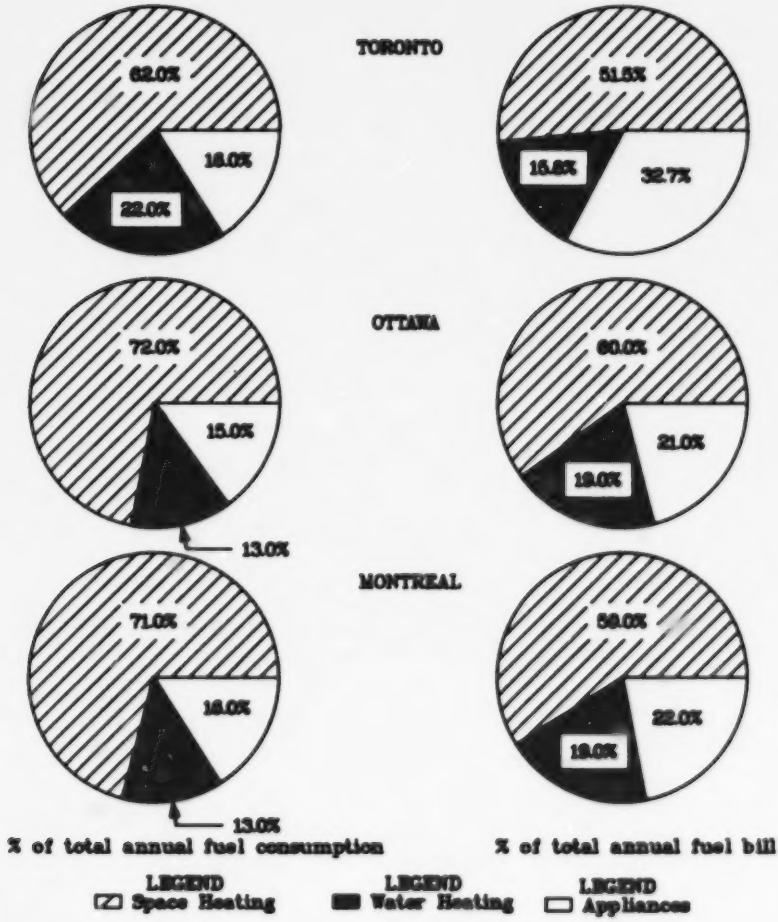


Figure 2.3: Disaggregated Household Energy Consumption and Costs for Selected Canadian Cities, 1980

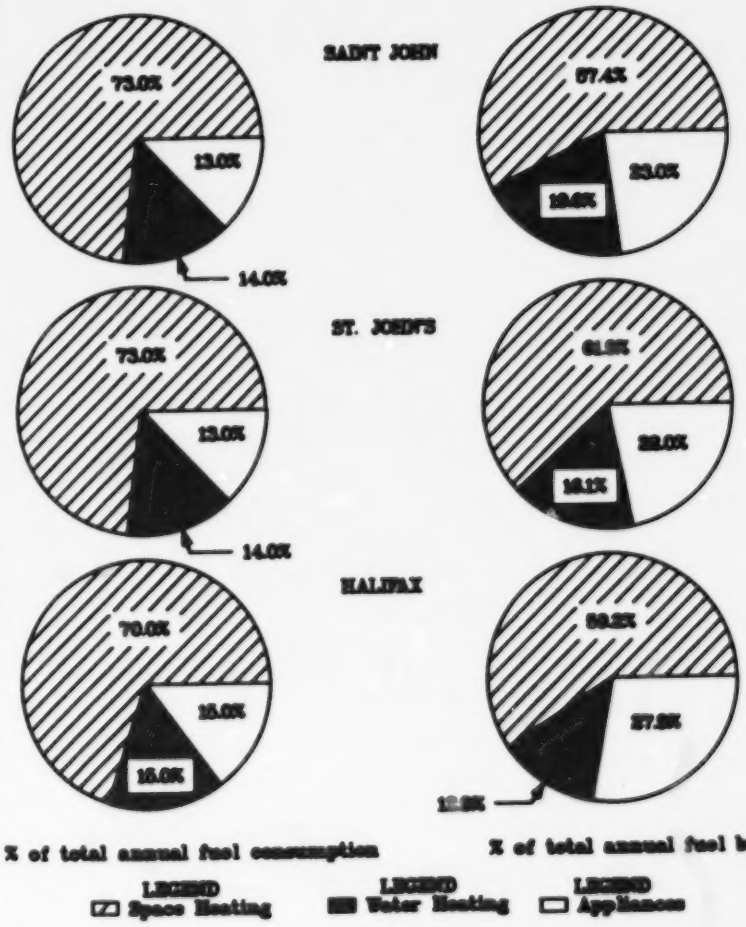


Figure 2.4: Disaggregated Household Energy Consumption and Costs for Selected Canadian Cities, 1980

Footnotes

[1]One British Thermal Unit is the amount of heat necessary to raise the temperature of one pound of water one degree Fahrenheit.

[2]Canada Mortgage and Housing Corporation, The Conservation of Energy in Housing, (Ottawa: Canada Mortgage and Housing Corporation, 1977), p. 31.

[3]T. H. Handley and C. J. Barton, Home Ventilation Rates: A Literature Survey, (Oakridge National Laboratory, September 1973), ORNL - TM - 4318.

[5]Canada Mortgage & Housing Corporation, op. cit., pp. 31-32.

[6]Ibid, p. 68.

[7]Although the 1977 National Building Code Standards were considered adequate at the time of publication, they are now considered by many sources to provide only minimum levels of energy efficiency in new housing. Subsequent revisions provide for much higher standards of thermal resistance.
See: "Measures for Energy Conservation in New Buildings," issued by the Associate Committee on the National Building Code, National Research Council of Canada, (Ottawa, 1978), NRCC 16574.

[8]See Appendix C.

[9]A degree hour is the difference between an assumed base temperature of 65° F and the actual outside temperature. If the outside temperature is below 65° F, the degree hour is recorded as a heating degree hour. For example, if the temperature outside is 30° F, the degree hour is recorded as a 35 degree heating hour (64° - 30° = 35°).

[10]Total annual degree days is the sum of the differences between 65° F and the average degree hour (over a 24-hour period) for every day in the year when the average degree hour is below 65° F.

[11]John A. Murphy, The Homeowner's Energy Guide, (New York: Thomas Y. Crowell Company, 1976), p. 87.

[12]Canada Mortgage and Housing Corporation, op. cit., p. 32.

[13]E. C. Hise and A. S. Hohm, Heat Balance and Efficiency Measurements of Central Forced Air Residential Gas Furnaces, (Oakridge National Laboratory, ORNL-NSF-EP-88, October 1975), p. 4.

[14]Canada Mortgage and Housing Corporation, op. cit., p. 32.

[15]Ibid, p. 32.

[16]Ibid, p. 32.

[17]Canadian Electrical Association, Improved Energy Efficient Water Heater, 77-51, February 1979, p. i.

[18]Ibid, p. i.

[19]Canada Mortgage and Housing Corporation, op. cit., p. 121.

[20]The fuels considered in the analysis are those which are used most prevalently, in each particular city, for the specific function of space heating, water heating, and/or appliance operation. They are as follows:

City	Space Heating	Water Heating	Appliance Operation
Victoria	Oil	Electricity	Electricity
Vancouver	Gas	Gas	Electricity
Calgary	Gas	Gas	Electricity
Edmonton	Gas	Gas	Electricity
Regina	Gas	Gas	Electricity
Winnipeg	Gas	Gas	Electricity
Toronto	Gas	Gas	Electricity
Ottawa	Oil	Electricity	Electricity
Montreal	Oil	Electricity	Electricity
Saint John	Oil	Electricity	Electricity
St. John's	Oil	Electricity	Electricity
Halifax	Oil	Oil	Electricity

Chapter 3

APPLIANCE ENERGY USAGE

Introduction

Although the major part of this study addresses itself to upgrading of the building shell and heating equipment, potential exists for significant savings in other areas of residential energy use. Referring to Figures 2.1 to 2.3, in the preceding chapter, appliances and lighting account for approximately 11 to 18 percent of total annual household energy consumption. This is directly attributable to the trend toward saturation in major electrical home appliances over the past two decades (see Table 3.1), and to increased energy intensiveness in such appliances as frost-free refrigerators. Furthermore, in specific cities faced with substantial electricity costs, such levels of consumption can translate into nearly 45 percent of the total annual energy bill, indicating the exigency of achieving maximum levels of technically feasible appliance efficiency.

The purpose of the chapter is twofold: first, to discuss the current nature and status of energy conservation in home appliances; and second, to demonstrate and assess any further potential for energy and cost savings through redesign and modification of domestic appliances and lighting, given current and future technology.

3.1 Electricity Conservation in Household Appliances

It is evident from Table 2.8 that the principle portion of total appliance operating costs--nearly 76 percent--can be attributed to the major appliances and that therein must lie the greatest potential for using electricity more efficiently. Many small portable appliances also have a very high electricity consumption but are used relatively rarely, and thus have very small annual requirements. Currently, design improvements in such appliances are restricted to improving and upgrading motor efficiency. It is generally conceded, however, that more thorough redesign would yield much greater conservation potential. While it has been assumed that many of the major household appliances can be modified to incorporate more energy-

TABLE 3.1

PERCENTAGE OF CANADIAN HOUSEHOLDS WITH SPECIFIED ELECTRIC APPLIANCES
1960 and 1980

	Electric Range		Refrigerator		Freezer		Clothes Washer		Clothes Dryer		Dishwasher	
	1960	1980	1960	1980	1960	1980	1960	1980	1960	1980	1960	1980
British Columbia	50.4	90.5	90.3	99.2	12.7	55.5	19.7	64.6	12.2	59.0	-	37.7
Alberta	27.9	84.7	83.3	99.5	24.0	63.4	12.6	69.6	12.0	58.8	-	42.4
Saskatchewan	43.6	92.4	79.0	99.0	25.5	76.4	2.9	58.9	7.8	69.1	-	29.9
Manitoba	82.5	95.3	91.7	99.4	21.8	64.0	10.5	58.2	13.1	61.1	-	26.0
Ontario	75.0	88.4	96.1	99.7	11.2	51.2	13.2	59.9	1.6	54.4	-	25.2
Quebec	50.2	93.5	94.0	99.9	5.3	37.4	12.1	74.2	7.1	67.6	-	29.1
New Brunswick	31.0	87.7	79.5	99.5	6.8	53.9	8.3	62.3	6.1	63.7	-	18.1
Newfoundland	27.6	75.3	86.5	99.6	5.3	50.2	5.3	55.3	3.5	58.0	-	15.7
Nova Scotia	12.0	76.4	89.0	96.5	-	63.9	-	41.7	-	50.0	-	10.4

SOURCE: Dominion Bureau of Statistics Catalogue 64-202, Household Facilities and Equipment, May 1960; and Statistics Canada Catalogue 64-202, Household Facilities and Equipment, May 1980.

efficient features, research in electricity conservation in the domestic sector has only recently been initiated. This can be attributed to three factors.

First, it has been felt that household appliance energy consumption, and subsequently appliance operating costs, are relatively insignificant in relation to space and water heating. Consequently, a great deal of research to date has focused on the latter. However, it has been demonstrated in Chapter 2 that appliance operating costs can account for up to 42 percent of the total annual fuel bill, depending on the cost of electricity relative to fuels used for space and water heating in each Canadian city. More specifically, households in Halifax, for example, though faced with electricity costs approximately 100 percent higher than their counterparts in Calgary, (see Table 3.2) attribute only 30 percent of their total annual energy bill to appliance operation, as opposed to 42 percent in Calgary. It is evident, therefore, that considerable potential for appliance energy conservation exists, regardless of the discrepancy in electricity costs among individual Canadian households.

Secondly, it has been argued that because most appliances are used in conditioned space, waste heat from their operation contributes to internal heat gain, thus reducing the annual space heating load. A reduction in appliance electricity use would therefore require a corresponding increase in the amount of fuel used for heating purposes. Table 3.3 illustrates the potential radiant heat gains from selected home appliances over a typical eight month heating season. While heat gains from appliances could be expected to approach 18 million BTU (18.9 gigajoules) per heating season, only 35 percent of waste heat from appliances is estimated to directly contribute to space heating. Thus, the figure is probably closer to only 6 million BTU (6.33 gigajoules). Consequently, one would expect improvements in appliance efficiency to have minimal impact within this context.

TABLE 3.2

MONTHLY ELECTRICITY BILLS FOR ELECTRIC APPLIANCES:
SELECTED LEVELS OF CONSUMPTION, 1980
(1980 dollars)

City and Utility	Electricity Consumption				
	250 kW.h	500 kW.h	750 kW.h	1000 kW.h	5000 kW.h
Victoria (B.C. Hydro)	13.50	20.59	27.21	33.84	139.84
Vancouver (B.C. Hydro)	13.50	20.59	27.21	33.84	139.84
Calgary (City of Calgary)	8.73	14.54	20.36	26.17	119.16
Edmonton (Edmonton Power)	8.75	14.50	20.25	26.00	118.00
Regina (Sask. Power Corp.)	9.78	16.06	21.96	27.86	112.26
Winnipeg (Winnipeg Hydro)	11.88	18.21	24.53	30.86	132.06
Toronto (Toronto Hydro-Electric Com.)	10.68	17.77	24.86	31.95	145.35
Ottawa (Ottawa Hydro-Electric Com.)	7.80	14.18	20.55	26.93	128.93
Montreal (Hydro-Quebec)	10.60	16.10	21.60	27.40	127.40
Saint John (Power Commission, City of Saint John)	14.11	24.61	34.62	42.63	170.79
St. John's (Nfld. Light and Power Co. Ltd.)	15.66	25.56	33.58	41.58	169.74
Halifax (Nova Scotia Power Corp.)	16.66	26.86	37.38	49.15	221.35

SOURCE: Statistics Canada, Electricity Bills, Catalogue 57-203, 1980.

TABLE 3.3

POTENTIAL HEAT GAINS IN THE HOME ATTRIBUTABLE TO MAJOR APPLIANCES (gigajoules)

Source	Heat Gain
Refrigerator	5.69
Stove	2.74
Freezer	4.11
Dishwasher	2.84
Automatic washer	2.42
Color television	1.16
Total	18.96

NOTE: Clothes dryer is not included as most potential heat gains are vented outside.

Third and last, it has been assumed that consumers are not willing to pay a higher price for more energy-efficient appliances. However, unless specific energy information is made available, it is difficult to determine whether consumers will make sensible choices among alternative products with regard to their respective energy consumption and cost of operation.

To this end, the federal Department of Consumer and Corporate Affairs, in conjunction with the Canadian Standards Association (CSA) and the appliance manufacturing industry has introduced a program to aid consumers in selecting appliances which use the least amount of energy in performing their tasks. Under the Consumer Packaging and Labelling Act, the program designated as 'Energuide' requires energy consumption labels stating monthly kilowatt hour energy consumption, as tested and verified by the CSA, to be affixed to certain household appliances. These include all those major appliances manufactured after the following dates:

Appliance	Date
Refrigerators	September 30, 1978
Freezers	November 30, 1979
Clothes washers	October 30, 1980
Dishwashers	October 30, 1980
Ranges	December 30, 1980
Clothes dryers	June 30, 1981

The success of the labelling program in producing energy savings will largely depend on the extent to which consumers respond by selecting more energy-efficient appliances.

3.2 Future Potential for Appliance Energy Conservation

While it has been generally agreed that major appliances can be redesigned to improve energy efficiency over their useful economic lives, the future potential for conservation has been difficult to ascertain due to a lack of research on the topic.

One notable study, carried out as part of the 'DEMO' project on energy options for Denmark, deals with the possibilities for reducing future appliance electricity consumption. It was motivated by the lack of data on domestic energy conservation strategies. The study describes how domestic appliances (excluding water and space heaters) and lighting devices can be redesigned to use electricity more efficiently under three conservation strategies--moderate, strong, and radical. The results, though based on Danish appliances and behavioral patterns, can be extrapolated to other countries and are shown to be economically attractive and technically feasible.

The only study of this nature conducted in a Canadian context is a report prepared by Ontario Hydro for the Canadian Electrical Association entitled "Energy Analysis of Major Household Appliances."[1] Employing an approach similar to that of the Danish study, an attempt is made to assess the impact on Canadian households of improving the energy efficiency of six major home appliances--refrigerators, ranges, freezers, dishwashers, automatic washers, and clothes dryers. The report evaluates not only those energy saving design features which are currently technically feasible, but also those which will be marketable given an additional three to five years of research and development. A summary of the potential savings through reduced energy consumption by appliance type is presented in Figure 3.1. The results indicate that substantial savings can currently be realized for all appliances except

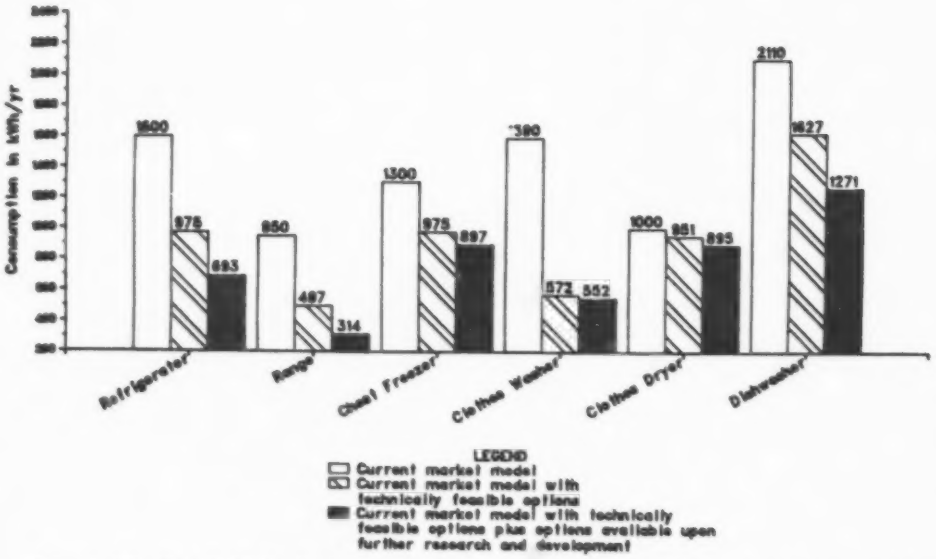


Figure 3.1 : Household Appliance Electricity Consumption With Energy Saving Design Features

the automatic dryer, while further study and development would result in additional savings, especially for the electric range, refrigerator, and automatic washer.

A more detailed account of efficiency design improvements for specific major appliances, as determined by Ontario Hydro, is presented in the following sections.

3.2.1 Refrigerator-freezer

Refrigerators currently on the market use approximately 1200 to 1800 kW.h of electricity annually, depending on model, manufacturer and degree of maintenance. This is nearly double that of earlier models[2] and can be attributed to such factors as a decline in insulation quality[3], increased interior volume and such accessories as automatic icemaker, electrical defroster, and electrically heated butter compartments. Subsequently, refrigerator-freezers now account for 16 percent (standard model) to 26 percent (frost-free model) of all electricity used for lighting and appliances in Canadian households, thereby providing significant potential for energy and cost savings.

Refrigerators are designed specifically to maintain a desired temperature difference between the interior and exterior of the cabinet. This requires a refrigeration system capable of removing heat which is continuously being admitted to the interior through the insulation in the door and walls, leaks in the door seals, and where applicable, defrosting units in which the evaporator is heated electrically. Further contributions to the thermal load occur with frequent openings of the refrigerator door and when warm food is placed in the cabinet (see Figures 3.2 and 3.3).

According to the Ontario Hydro report, currently marketable design improvements to reduce electricity consumption are concentrated around upgrading thermal insulation and door seals, while simultaneously improving the efficiency of both the motor and anti-sweat heater. Table 3.4 indicates that these four design improvements alone are estimated to produce savings of 39 percent. With additional research and development over a three to five-year period, further energy savings from the six specified innovations would equal 29 percent. This would result in aggregate potential savings of 68 percent, thus reducing annual kW.h consumption from 1600 to 693 kW.h at a total estimated cost of $23.44.[4]

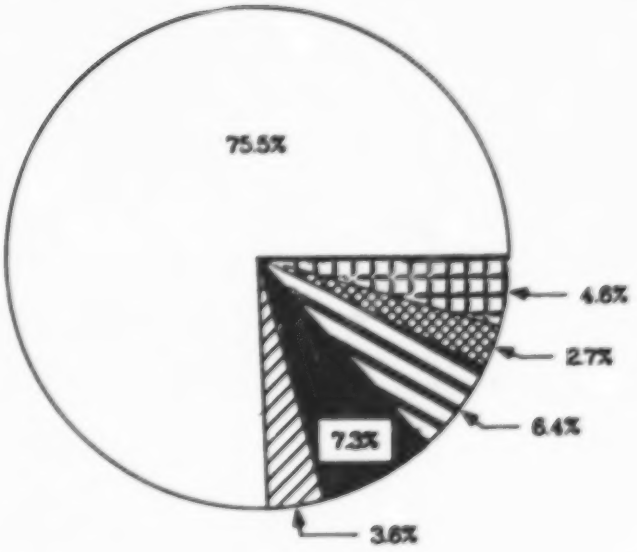
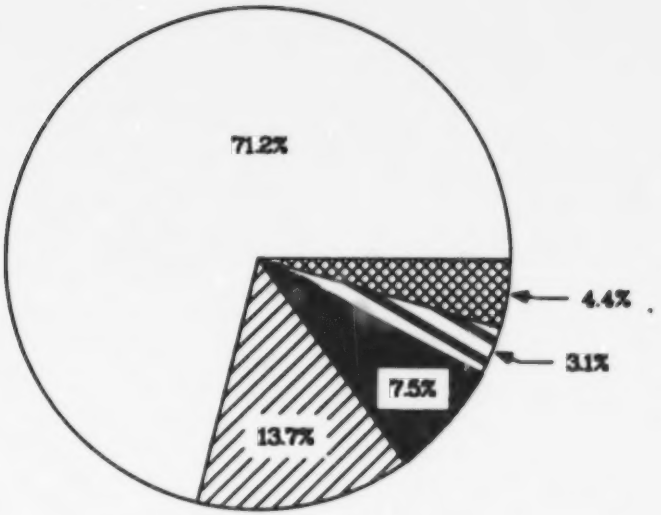


Figure 5.2: Disaggregated Electricity Consumption for a Refrigerator



LEGEND

- Heat transmission through walls and door
- Leaks at door seal
- Heat introduced by food load and door opening
- Heat from seals
- Electricity for heating seals

Figure 3.3 : Disaggregated Electricity Consumption for a Freezer

TABLE 3.4

ELECTRICAL ENERGY SAVING DESIGN FEATURES FOR REFRIGERATOR-FREEZERS, ESTIMATED ANNUAL CONSUMPTION 1600 kW.h[a]

Design Improvement	Energy Savings		Dollar Savings
	Percent	kW.h	$1981
Technically Feasible:	39	625	16-32
(1) Substitute urethane foam for fibre-glass insulation in walls and door			
(2) Improve motor efficiency			
(3) Redesign anti-sweat heater			
(4) Improve door seals			
Further Research and Development:	29	282	7-14
(1) Improve compressor efficiency			
(2) Optimize refrigeration cycle			
(3) Redesign evaporator			
(4) Redesign condenser			
(5) Relocate evaporator fan			
(6) Improve refrigerant			
AGGREGATE SAVINGS	68	907	23-46

SOURCE: Ontario Hydro, Energy Analysis of Major Household Appliances, Canadian Electrical Association, Toronto, 1981, Appendix B.

[a]Based on a 16 ft^3 nominal capacity, frost-free, and 2-door top.

3.2.2 Ranges

The present average kilowatt hour consumption for electric ranges is approximately 950-1200 kW.h annually per household. However, as illustrated in Figure 3.4, more than 55 percent of all energy used is attributable to heat losses from the oven and hotplates during operation, while less than 15 percent actually goes to cooking the food. In addition, a large portion of electricity consumed is used to heat cooking equipment and components of the stove itself, such as hotplates, the oven casing and insulation material.

According to Table 3.5, results of Ontario Hydro indicate significant savings of nearly 50 percent are achievable with the implementation of six separate design improvements. Modifications to the oven would include a forced air oven circulator, improved insulation and oven door seals, and a reduction in the oven vent area. Stove surface features would include greater surface element area combined with reflective element pans.

Additional research and development could see savings of up to 37 percent with such oven innovations as a reduction in thermal mass, reflective interiors, and anti-convection interior elements and surface modifications to flatten elements.

The wide range of cooking practices makes it difficult to generalize about potential savings, but Table 3.5 indicates aggregate savings of 85 percent, or alternatively, a reduction in consumption from 950 to 314 kW.h per year. These energy-saving design features have been estimated by Ontario Hydro to increase unit costs to the appliance manufacturer by $50.65, including labour, materials, purchased parts, and investment costs.[5]

3.2.3 Clothes Washers

Clothes washers belong to a group of appliances (including dishwashers and clothes dryers) in which most of the electricity consumed is used to produce low temperature heat (below 100° C) which, in this case, is used specifically for heating water for the various cycles (see Figure 3.5). However, recent progress in the field of detergents has partly eliminated the need for previous levels of hot water. Now, instead of choosing the highest temperature that the textiles can stand, it is possible to choose the lowest temperature necessary to achieve clean laundry.

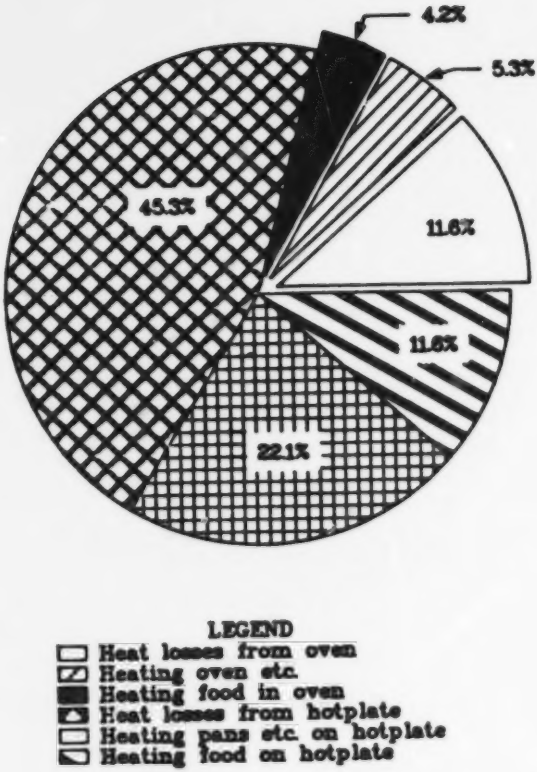


Figure 3.4 : Disaggregated Electricity Consumption for a Range

TABLE 3.5

ELECTRICAL ENERGY SAVING DESIGN FOR RANGE FEATURES ESTIMATED ANNUAL CONSUMPTION 950 kW.h[a]

Design Improvement	Energy Savings		Dollar Savings
	Percent	kW.h	$1981
Technically Feasible:	48	453	12-23
(1) Forced air oven circulator			
(2) Improved oven door seals			
(3) More efficient insulation			
(4) Greater surface element area			
(5) Reduction in oven vent area			
(6) Reflective element pans			
Further Research and Development:	37	183	5-9
(1) Reflective oven interior			
(2) Reduction in oven thermal mass			
(3) Anti-convection element			
(4) Flatter elements			
AGGREGATE SAVINGS	85	636	17-32

SOURCE: Ontario Hydro, Energy Analysis of Major Household Appliances, Canadian Electrical Association, Toronto, 1981, Appendix B.

[a]Based on several 30-inch nominal size range 4 element cook top with oven below, self-clean models and a forced air convection oven.

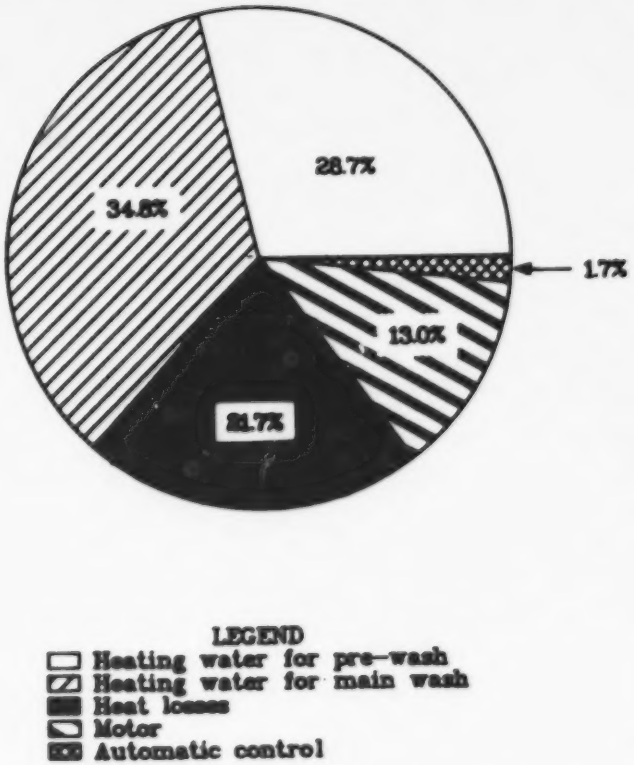


Figure 3.5 : Disaggregated Electricity Consumption for a Washing Machine

Most modifications which are designed to reduce hot water consumption without reducing the level of water in the tub appear as a feasible means of conserving electricity with no decline in washing standards (see Table 3.6). These include elimination of hot rinse, front load washer, solid tub, and suds saver which, when accompanied by improved motor efficiency, provide savings in electricity consumption of up to 64 percent. Further research and development provides very little in the way of further savings--only 3 percent--for such measures as fixed temperature mixing values and increased spin speed.

Total savings for clothes washers would approximate 67 percent or 1038 kW.h annually, at an additional unit cost of $54.68.[6]

3.2.4 Clothes Dryers

The benefits provided by a clothes dryer, as compared to drying in the open air, are the savings of labour and time and an independence from weather conditions. Heating the air in the clothes dryer mainly speeds up the process.

Figure 3.6 indicates that approximately 80 percent of all electricity is used for heating the incoming air while the remaining 20 percent can be attributed to both the motor and automatic control. Consequently, most design options for clothes dryers, specified by Ontario Hydro, involve limiting the amount of energy required for creating and maintaining a specified level of low temperature heat.

According to Table 3.7, there exists a total of six design options for improving energy efficiency in domestic clothes dryers. Aggregate savings, however, amount to only 22 percent of 105 kW.h annually. There are basically only two modifications--additional thermal insulation and heat design--which are technically feasible. Redesigning the dryer chamber, blower, and control, while improving spin speed and heat recovery are those measures available upon further research and development. Design improvements which are either technically feasible or which require further research provide only 5 and 6 percent energy savings respectively, at an additional cost to the manufacturer of $4.06.[7]

TABLE 3.6

ELECTRICAL ENERGY SAVING DESIGN FEATURES FOR AUTOMATIC CLOTHES WASHERS, ESTIMATED ANNUAL CONSUMPTION 1590 kW.h[a]

Design Improvement	Energy Savings		Dollar Savings
	Percent	kW.h	$1981
Technically Feasible:	64	1018	26-52
(1) Elimination of hot rinse[b]			
(2) Front Load washer[b]			
(3) Solid tub[b]			
(4) Suds saver[b]			
(5) Improve motor efficiency			
Further Research and Development:	3	20	0.5-1
(1) Fixed temperature mixing values			
(2) Increase spin speed			
AGGREGATE SAVINGS	67	1038	27-53

SOURCE: Ontario Hydro, Energy Analysis of Major Household Appliances, Canadian Electrical Association, Toronto, 1981, Appendix B.

[a]Includes heating of water which amounts to 1500 kW.h/year.

[b]Energy savings are attributable only to a reduction in hot water consumption.

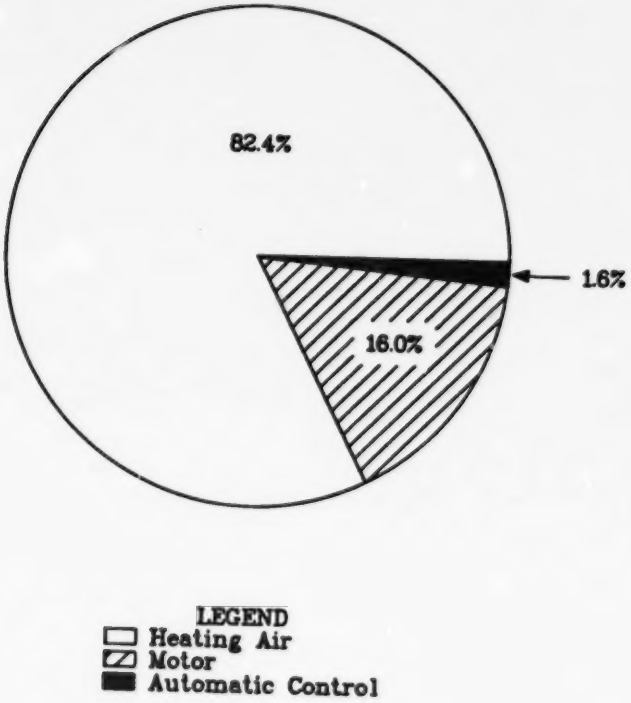


Figure 3.6 : Disaggregated Electricity Consumption for a Clothes Dryer

TABLE 3.7

ELECTRICAL ENERGY SAVING DESIGN CHANGES FOR ELECTRIC CLOTHES DRYERS, ESTIMATED ANNUAL CONSUMPTION 1000 kW.h[a]

Design Improvement	Energy Savings		Dollar Savings
	Percent	kW.h	$1981
Technically Feasible:	5	49	1-2
(1) Additional thermal insulation			
(2) Heat redesign			
Further Research and Development:	6	56	1.5-3
(1) Redesign dryer chamber			
(2) Redesign blower and control			
(3) Improve spin speed			
(4) Heat recovery			
AGGREGATE SAVINGS	11	105	2.5-5

SOURCE: Ontario Hydro, Energy Analysis of Major Household Appliances, Canadian Electrical Association, Toronto, 1981, Appendix B.

3.2.5 Dishwashers

Washing dishes by machine uses less energy than doing the same amount by hand, plus it has the additional advantage of saving both labor and time. Handwashing requires approximately seven gallons of hot water three times a day, while an automatic dishwasher can hold one to two days' load of dishes and run once using thirteen gallons of hot water. Furthermore, omitting the drying cycle significantly increases potential energy savings. Not only do automatic dishwashers save energy, but the high water temperatures contribute to superior levels of grease removal and hygiene.

Dishwashers are, in many respects, similar to washing machines and thus exhibit many of the same energy utilization patterns. Specifically, as Figure 3.7 indicates, approximately 81 percent of all energy usage can be attributed to supplying and maintaining a specific level of hot water for washing and rinsing cycles (including heat losses), while only 19 percent is required to actually run the machine. Thus, as with clothes washers, the greatest potential for conservation lies with those measures designed to reduce the amount of hot water required for a full wash cycle.

Given those options which are technically feasible, three measures, namely--reduction in number of rinse cycles, modification of wash chamber and increased accuracy of fill control--are designed to provide energy savings attributable to a reduction in hot water consumption. Two additional modifications--improved motor efficiency and optional hot dry cycle--if combined with the aforementioned measures, provide total energy savings of 23 percent. These modifications are specified in Table 3.8. It can also be observed in this table that further research and development would allow for provision of a cold water rinse and additional savings of 25 percent.

3.2.6 Lighting

Lighting is not the greatest energy consumer in the home, but it has the potential of using more energy and costing more than many heating systems. An average home contains approximately thirty 100 watt electric incandescent bulbs, and if all these burned constantly, the monthly electric bill for lighting would be greater than any other domestic power users. Lighting, however, is an area where alterations can be made and conservation measures practiced with effective results. The following alterations in present lighting systems and suggestions

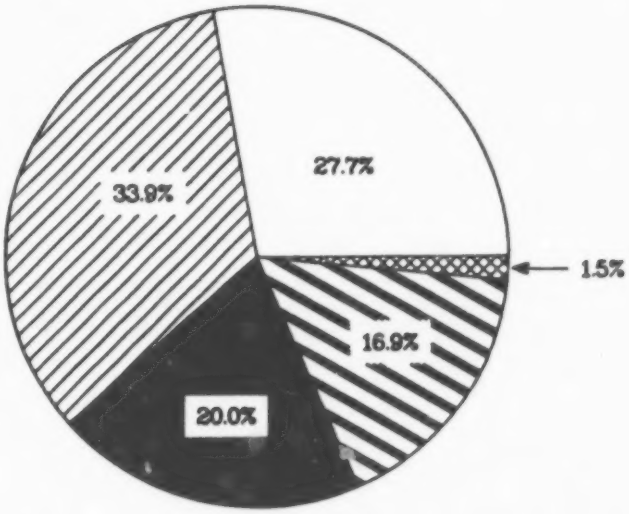


Figure 3.7 : Disaggregated Electricity Consumption for a Dishwasher

TABLE 3.8

ELECTRICAL ENERGY SAVING DESIGN FEATURES FOR AUTOMATIC DISHWASHERS, ESTIMATED ANNUAL CONSUMPTION 2110 kW.h[a]

Design Improvement	Energy Savings		Dollar Savings
	Percent	kW.h	$1981
Technically Feasible:	23	483	13-25
(1) Optional hot dry			
(2) Improve motor efficiency			
(3) Reduce number of rinse cycles[b]			
(4) Modify wash chamber[b]			
(5) Increase accuracy of fill control[b]			
Further Research and Development:	25	356	9-18
(1) Cold water rinse[b]			
AGGREGATE SAVINGS	48	839	22-43

SOURCE: Ontario Hydro, Energy Analysis of Major Household Appliances, Canadian Electrical Association, Toronto, 1981, Appendix B.

[a]Includes hot water at 1830 kW.h/yr.

[b]Energy savings are attributed only to a reduction in hot water consumption.

for economical usage not only save energy and money, but improve present lighting quality and effectiveness.

Light is measured in lumens; the brighter the bulb, the more lumens are given off. The watt, on the other hand, is a measure of electrical power used to produce light or heat and, contrary to popular belief, is not the measure of the amount of light received from the bulb. Without knowing both watts and lumens for either incandescent bulbs or fluorescent tubes, it is impossible to determine their efficiency in converting electrical energy to light, and this information is rarely given on either bulbs and tubes or cartons.

A 40-watt, incandescent bulb gives off an average of 445 lumens of light, which means that it produces 11 lumens per watt of electricity. The same 40-watt, fluorescent tube gives off an average of 3150 lumens of light, which divides out to approximately 78 lumens per watt. Thus, the fluorescent tube provides seven times the amount of light the incandescent bulb does for the same amount of electricity. Though fluorescent tubes usually cost considerably more, they usually last twice as long, and their energy savings more than offset their higher cost. Table 3.9 presents estimated payback period for different frequencies of usage of fluorescent tubes instead of incandescent bulbs, assuming electricity rates of 2.7¢/kW.h.

TABLE 3.9

PAYBACK PERIODS FOR THE USE OF FLUORESCENT LAMPS INSTEAD OF INCANDESCENTS (for equal wattage fixtures)

Hours of Use/Day	Payback Period (years)
3	2.8
6	1-4
9	under 1

SOURCE: Housing and Urban Development Association of Canada (HUDAC), Builders' Guide to Energy Efficiency in New Housing, January 1980.

Often light is lost by enclosing bulbs in shades and fixtures designed to let little light escape. Ceiling and wall bulbs enclosed in metal or wooden 'can-type' fixtures only provide light out one end,

and consequently there is great waste in these aesthetic features. Instead of using a 100-watt bulb and then reducing the light emitted by use of an opaque shade, it is recommended that a 40-watt bulb be used in combination with a shade that allows most of the light to shine through, but diffuses and eliminates glare. It will provide the same amount of light and the same effect at a lower cost.

The colors of interior walls, ceilings, floors, and furnishings can also greatly determine the degree of benefit gained from lighting, whether it be natural or artificial. Colors either absorb or reflect light, so the amount of ambient light (that which fills the room) ultimately available for use is determined by (1) the amount originally put into the room, and (2) the amount remaining after absorption by all surfaces in the room such as ceilings, walls, floor, furniture, draperies, and all other objects. Table 3.10 gives the reflectance of various building components as recommended by Ontario Hydro.

TABLE 3.10

RECOMMENDED INTERIOR REFLECTANCE VALUES

Surface	Reflectance Value (%)
Ceiling	80-90
Walls	40-60
Floors	25-45 (typical)
Furniture	20-40 (typical)

SOURCE: HUDAC, Builders' Guide to Energy Efficiency in New Housing, January 1980.

To get maximum benefit from lighting, the lightest colors possible should be used for all interior house surfaces and furnishings as dark surfaces absorb light thus decreasing the ambient light level.

Even after making energy-saving alterations in the home, lighting bills can remain the same or even become higher if energy conservation is not practiced daily. Extravagant, wasteful use of electric lights will negate all benefits gained by lighting changes designed to use the current lighting system more efficiently.

Footnotes

[1]R. Drapkin, "Energy Analysis of Major Household Appliances",(Toronto: Ontario Hydro, Economics Division, March 15, 1981).

[2]Ibid., Appendices A and B.

[3]Ibid.

[4]Using electricity cost structure outlined in Table 2.11.

[5]R. Drapkin, op. cit., p. 35.

[6]Ibid.

[7]Ibid., p.34.

Chapter 4

OPTIONS FOR THE FUTURE

4.1 Introduction

The first three chapters of this study were devoted to identifying and comparing household energy costs in twelve urban areas of Canada. These comparisons show that total annual costs vary greatly across the country due to variations in climatic conditions, types of energy available and energy prices. These three factors have had a strong influence on the results of research conducted into methods by which increasing real energy costs can be mitigated. Some results of this research will be presented in this final chapter in order to provide homeowners with an estimate of the potential benefits of taking action to reduce the amount of energy consumed in their homes. It will become evident that a significant pecuniary benefit can be gained in every city in the sample through implementation of some or all of the conservation measures discussed.

In Chapter 3, three general areas of household energy use were identified as targets for energy conservation or substitution. These were space heating, domestic water heating and electrical appliance use. Each of these areas has been investigated to determine the quantity of energy which might be saved by implementing various conservation options.

Reduction of space heating costs (the largest contributor to energy costs) can be accomplished in existing housing through retrofitting various components with greater levels of thermal resistance. These costs can also be reduced in many areas of the country by substitution of lower priced competing energy forms. A reduction in the temperature of ambient air in the house will also effectively reduce the heating load. The relative benefits of these three cost-reducing options are discussed in this chapter.

Energy required for domestic water heating accounts for the second largest proportion of total energy costs. This cost can be reduced through measures similar to those suggested above for space heating. Stand-by losses of the hot water tank can be reduced through the

addition of thermal insulation, while heating load can be decreased through the use of flow restrictors which reduce the flow of hot water. If oil is used for water heating, substitution to natural gas, electricity or other forms of energy may reduce annual operating costs considerably.

The third major energy user group in the home consists of electrical appliances. Chapter 3 indicated that there is a considerable potential to reduce electricity use through the redesign of most appliances. The following sections will focus on the first two groups, investigating the costs and benefits of taking action to conserve energy or to substitute alternative energy sources in both space heating and domestic water heating.

4.2 Study Methodology

Estimates of the financial attractiveness of the energy conservation and substitution options noted above can be produced in a variety of ways. The methodology chosen here--the calculation of the length of payback period--is straightforward and understandable to the layman. Most of the options identified in this study involve the installation of some type of equipment or material which requires a capital outlay for both material and labor. This represents an investment cost which will be returned to the homeowner via a reduction in energy costs over a time period. It normally takes several years for the savings to completely repay the initial investment. The number of years required for a complete repayment is called the payback period.

The estimates of the payback period provided here vary from immediate to greater than ten years. The reader should be aware that those options with the fastest payback period are not necessarily those with the greatest present value. The present value (P.V.) of an amount accruing in the future is calculated using the formula: $P.V. = P (1 + R)^{-t}$, where P is the future amount, or principal, R is the interest or discount rate and t is the time period coincident with the interest rate period.

For purposes of the analysis all investment costs are assumed to be incurred in the first year. The benefits, expressed in terms of reduced quantities of energy used, are assumed to accrue in equal annual amounts for a ten-year period. Estimates of benefits are not made for longer than a ten-year period because of the difficulty in accurately predicting energy prices. Benefits have been estimated from

the 1981 base year up to and including 1990. These benefits are expressed in present (1981) dollar values by discounting at the estimated rate of consumer price inflation plus a real discount rate of 4 percent per year.

In some cases the installation of materials and equipment is simple enough so that the homeowner himself can do the job, thus avoiding labor costs. Adding insulation may be an example. Installation of a new gas furnace, however, must be done by a qualified tradesperson and the work approved by an inspector. As will become evident in the tables which follow, the homeowner who supplies his own labour will experience a faster payback period than the homeowner who hires a contractor. For this reason estimates of owner-installed and contractor-installed costs are given for all options.

4.3 Energy Pricing Assumptions

The relative movement of residential energy prices is of prime concern to every homeowner considering any of the conservation or substitution options suggested here. For a variety of reasons, however, future energy prices cannot be known with certainty, but reasonable estimates can be made on the basis of current and projected market conditions and government policies. For the purpose of this chapter, energy price estimates published by Canadian Enerdata Limited were used.[1] For both fuel oil and natural gas, two scenarios were used: a high case and a most likely case. For electricity prices only one scenario is given. These projections, expressed in average provincial terms, are shown in current dollars for all twelve cities studied in Appendix A. Both most-likely and high price scenarios for refined petroleum products, such as fuel oil, are based upon projections of Canadian crude oil prices which, in turn, are based on forecasts of world oil prices. 'Old oil' prices in Canada will be set equal to a maximum of 75 percent of crude oil import costs. 'New oil' prices in Canada are set equal to internationally traded oil landed at Montreal, subject to a quality adjustment. A weighted average of these and other prices is used to determine the blended price. Fuel oil prices used here assume that these and other fundamental regulations resulting from the September 1981, Alberta/Canada pricing agreement remain intact.

Natural gas prices in Canada are directly tied to the price of oil. On an energy content basis, the Toronto City Gate gas price will be maintained at 65 percent of the refiner's acquisition price of crude oil at Toronto.

Electricity price increases are related to oil and gas pricing, but are also dependent on provincial regulatory policies. It was assumed that Canadian average retail electricity prices will rise at 14.29 percent per year from 1981 to 1986 and at 10.01 percent per year from 1986 to 1991.[2]

In most of the tables that follow, estimates of energy cost savings will be presented for both natural gas and fuel oil with 'most-likely' and 'high energy price' scenarios, while estimates involving electricity will be presented on the basis of only one price scenario.

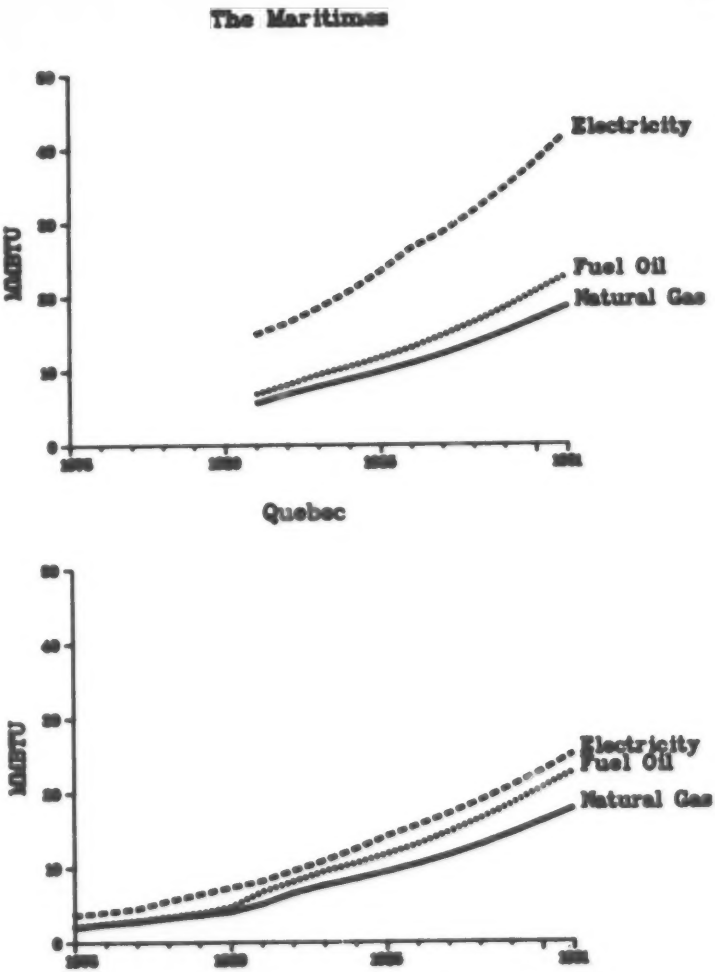
The reader should remember that the energy prices used are provincial averages. For this reason homeowners who make their own calculations based on regional energy prices and rate structures may produce estimates which are marginally different from those given here.

Figures 4.1 to 4.3 show forecast movements of residential energy prices and energy price indices for the five main regions of Canada.

4.3.1 Government Incentives

In recent years, both Federal and Provincial governments have implemented various programs aimed at inducing households to conserve energy and also substitute other forms of energy for oil. One conservation program is the Canadian Home Insulation Program (CHIP) administered by Energy, Mines and Resources Canada. The CHIP program offers monetary grants of up to $500 for the addition of insulation in the existing housing stock built prior to 1971 in most of Canada. As well, the Canadian Oil Substitution Program (COSP) offers grants of up to $800 for conversion of space heating systems from oil to natural gas, electricity or other forms of non-oil energy.

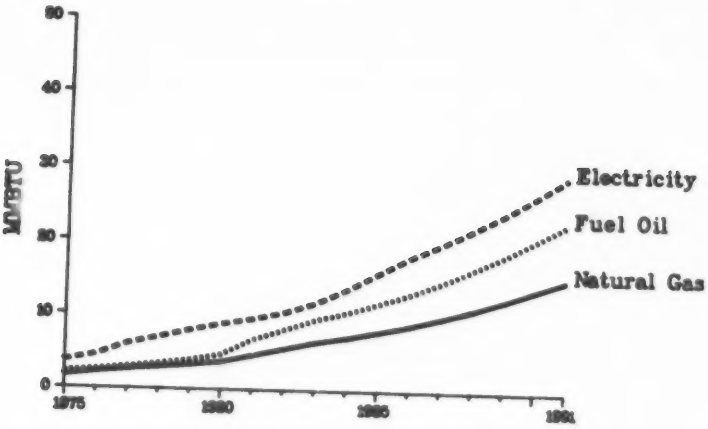
These grants have clearly been successful in inducing conservation and substitution through reducing the magnitude of the initial investment cost, which effectively reduces the payback period for the homeowner. However, for the purpose of this study, the value of the grants has not been included in the calculation of the payback periods because they are taxable benefits. The value of either grant to a homeowner is thus less than its face value and will vary with the level of the marginal income tax rate. For this reason it should be kept in



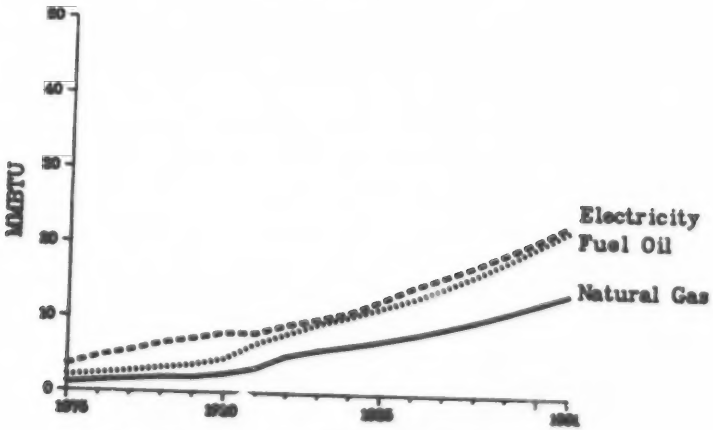
Note: The prices per btu for different fuels have not been adjusted for end use efficiency.

Figure 4.1: Retail Energy Prices (Residential) per Million BTU

Ontario

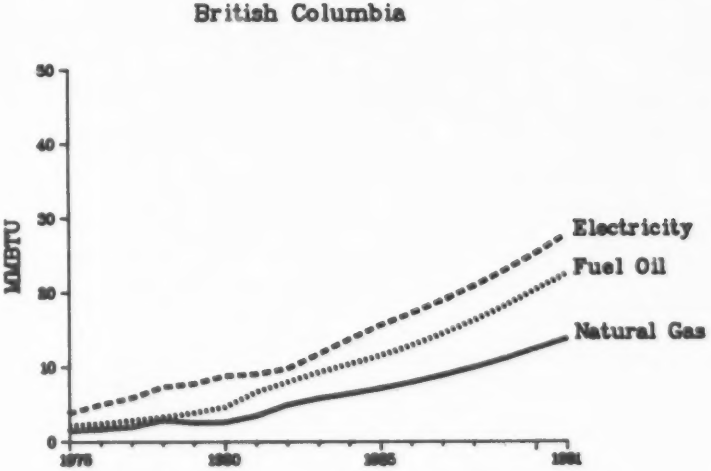


The Prairies



Note: The prices per btu for different fuels have not been adjusted for end use efficiency.

Figure 4.2: Retail Energy Prices (Residential) per Million BTU



Note: The prices per btu for different fuels have not been adjusted for end use efficiency.

Figure 4.3: Retail Energy Prices (Residential) per Million BTU

mind that, if a homeowner is eligible for a grant, the payback period will actually be less than indicated in the tables below. The attractiveness of the investments in retrofitting household insulation and substituting heating fuel may thus be further enhanced.

4.4 Format of the Analysis

Twelve major urban areas in Canada were identified and total household energy costs were estimated for three typical kinds of residential housing in each city in Chapter 2. Chapter 4 is devoted to estimating the costs and benefits and payback periods for four general types of conservation and substitution options in all twelve cities and for three house types. Calculation of benefits for all these variables results in a great deal of information which is difficult to incorporate in its entirety into a single chapter. For that reason, in most cases only results obtained for the city of Ottawa, the representative city of Chapter 2, are presented here. Results for the other eleven cities in the sample are presented in Appendices B and C. Householders in cities other than Ottawa should read through the text accompanying this chapter and then consult Appendices B and C for the tables pertaining to their own locale.

4.5 Substitution of Alternative Forms of Energy for Space Heating

Table 2.5 in Chapter 2 shows the composition of fuels used for space heating in Canada in the late 1970s. It clearly shows that light fuel oil was still a common source of space heating energy in many Canadian cities, especially outside of the four western provinces. One goal of the National Energy Program is to reduce the use of oil in the residential sector to no more than 10 percent of total energy used. An estimation of the differences in heating costs resulting from the use of different fuels shows that burning oil is quickly becoming the most expensive way to heat a home in almost all areas of Canada.

For example, in Ottawa, a city which has a more moderate winter climate than many other Canadian cities, space heating costs for the single-detached house (see Table 1.1) using oil, based on an average seasonal heating load of approximately 76 gigajoules, would have cost $726 to heat in 1981. By 1985, it would cost $1,270 (in current 1985 dollars) and in 1990, $2,216. Supplying the same heating load (76 gigajoules) with natural gas would cost $413 in 1981, $715 in 1985 and

$1,238 in 1990. Using electricity would result in annual heating costs of $616, $1,026 and $1,712 in those years in Ottawa.

In light of these results, it would clearly be advantageous to substitute either electrical energy or natural gas for fuel oil. Switching to electricity would have resulted in a saving of $110 in 1981. The present value of the cumulative saving by the end of 1990 would be $1,452.

If, instead, natural gas were used, the savings in 1981 would have been $313. The present value of the accumulated annual saving by 1990, would be $3,069.

These estimates are based on a 'most likely' price scenario. If oil prices escalate faster than this, the savings would be even larger. For example, under the high price scenario, the present value of savings by 1990 would be $2,600 and $3,590 for electricity and natural gas, respectively. These are savings clearly worth considering; unfortunately, they cannot generally be realized without a capital investment. In order to take advantage of these fuel cost savings, oil-burning equipment must be removed and either a natural gas burner or a complete furnace or electrical resistance heaters installed at considerable cost. Estimates of these capital costs appear in Table 4.1 along with estimates of first-year savings and payback periods for single-detached, semi-detached and row-houses. The relevant dimensions of these houses are given in Table 1.1 in Chapter 1 and are consistent through-out this study.

Two capital costs are given for the conversion to natural gas. That which appears first ($1,400) refers to the replacement of an entire oil furnace with a new conventional natural gas furnace (not a condensing gas furnace). The second natural gas option, with a cost of $700, refers to replacement of the oil burner only with a natural gas conversion burner. In those cases where the furnace cabinet and heat exchanger are in good condition, it may be possible to change only the burner and not replace the entire furnace. It will be noted that the costs for each option are the same for all housing types (and in Tables B1, B2 and B3 for all cities). Due to the difficulty in estimating the difference between these costs, it was decided to use common values. In reality it should not be surprising to find actual installed costs in various cities differing from these estimates. The same comment is also applicable to the electricity conversion costs of $2,500. This

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These estimates are based on a 'most likely' price scenario. If oil prices escalate faster than this, the savings would be even larger. For example, under the high price scenario, the present value of savings by 1990 would be $2,600 and $3,590 for electricity and natural gas, respectively. These are savings clearly worth considering; unfortunately, they cannot generally be realized without a capital investment. In order to take advantage of these fuel cost savings, oil-burning equipment must be removed and either a natural gas burner or a complete furnace or electrical resistance heaters installed at considerable cost. Estimates of these capital costs appear in Table 4.1 along with estimates of first-year savings and payback periods for single-detached, semi-detached and row-houses. The relevant dimensions of these houses are given in Table 1.1 in Chapter 1 and are consistent through-out this study.

Two capital costs are given for the conversion to natural gas. That which appears first ($1,400) refers to the replacement of an entire oil furnace with a new conventional natural gas furnace (not a condensing gas furnace). The second natural gas option, with a cost of $700, refers to replacement of the oil burner only with a natural gas conversion burner. In those cases where the furnace cabinet and heat exchanger are in good condition, it may be possible to change only the burner and not replace the entire furnace. It will be noted that the costs for each option are the same for all housing types (and in Tables B1, B2 and B3 for all cities). Due to the difficulty in estimating the difference between these costs, it was decided to use common values. In reality it should not be surprising to find actual installed costs in various cities differing from these estimates. The same comment is also applicable to the electricity conversion costs of $2,500. This

cost would result from installing permanent type baseboard resistance heaters and upgrading the service main to 200 amperes.

Table 4.1 shows savings in the first year after conversion for both a low level and a high level of insulation in the home. Conversion savings are much greater for houses which have low levels of insulation because the amount of heat energy required for a house with poor insulation is much greater. The relevant levels of insulation are given in Chapter 2 in Table 2.4 and are consistent throughout the study. Table 4.1 shows payback periods for three housing types in Ottawa for the various conversion options under high and low fuel price scenarios. The reader can easily see that, in many cases, the investment in equipment which uses natural gas is paid back very quickly. Where a conversion gas burner can be employed, at the lower capital cost of approximately $700, payback periods are only from one to four years. However, the high capital cost for electricity conversion and its relatively higher energy price results in a much longer payback period for this option, at least in Ottawa. In fact, this is generally true for most Canadian cities. Reference to Tables B.1 - B.3 in Appendix B shows that only in Winnipeg, where electricity prices have been frozen since May, 1979, do payback periods for this type of conversion fall significantly under ten years under all conditions. In Halifax, where electricity prices are higher than in any other city in the sample, heating with electricity is even more expensive than with oil.

As of the present time, four of the cities in the sample do not have access to natural gas service. These are Victoria, Saint John, St. John's and Halifax. Obviously, where pipeline facilities do not exist, natural gas is not a space heating option. However, a natural gas pipeline is being built in Quebec to points east of Montreal and the Atlantic provinces will eventually have ready access to gas, although the timing is uncertain. Significant discoveries of off-shore natural gas deposits at Sable Island may result in Maritime provinces using indigenous rather than Alberta gas in future. The new east coast sources of supply, however, are not likely to be commercially available much before 1990. Even less certain is a natural gas supply for Victoria. No commercial deposits of gas have been discovered on Vancouver Island yet, and cost estimates for an underwater pipeline indicate that it will be very expensive.

Generally, the results shown in Table 4.1 and Tables B.1 - B.3 show that converting a heating plant from fuel oil to either natural gas (where available) or electricity is a good investment with, in most

TABLE 4.1

CONVERSION TO AN ALTERNATIVE SPACE HEATING FUEL
OTTAWA

Conversion Options	Capital Cost ($1981)	Savings in First Year ($1981)				Payback Period (years)			
		Low Insulation	($)	Minimum Insulation	($)	Low Insulation		Minimum Insulation	
						Low Price Scenario	High Price Scenario	Low Price Scenario	High Price Scenario
SINGLE DETACHED:									
Oil to Natural Gas	1400	710	(43)	313	(43)	2	2	5	5
Oil to Natural Gas	700	710	(43)	313	(43)	1	1	3	3
Oil to Electricity	2500	252	(15)	111	(15)	8	5	>10	>10
SEMI-DETACHED:									
Oil to Natural Gas	1400	556	(43)	257	(43)	3	3	6	5
Oil to Natural Gas	700	556	(43)	257	(43)	2	2	3	3
Oil to Electricity	2500	197	(15)	90	(15)	10	6	>10	>10
ROWHOUSE									
Oil to Natural Gas	1400	427	(43)	189	(43)	4	3	8	7
Oil to Natural Gas	700	427	(43)	189	(43)	2	2	4	4
Oil to Electricity	2500	150	(15)	67	(15)	>10	8	>10	>10

cases, a payback period of less than 10 years. This is true for all three housing types in most cities. Overall, natural gas is the preferred option with savings generally 2 to 3 times as large as those produced by converting to electricity. Only in Halifax, where electricity prices are relatively high, is it not advisable to abandon fuel oil in favor of electricity for space heating purposes.

The savings in heating costs shown in Tables 4.1 and B1, B2 and B3 have been calculated using the standard method of determining the seasonal heating load. However, rather than reduce the amount by 15 percent to account for 'free' heat produced in the house from such sources as the occupants themselves, lights, appliances, etc., an absolute amount of 26,000 megajoules has been selected as a reasonable estimate for an average Canadian family of four.[3] This amount has been subtracted from the seasonal heating load to determine the amount of energy a heating plant must supply over the heating season. Referring once again to Table 4.1, the percentage figures given behind the savings in dollars represent the savings as a percentage of the original oil heating bill. For Ottawa these savings are considerable.

The reader should keep in mind that other forms of energy, although not specifically mentioned here, must not be overlooked as heat sources. Solar energy systems, heat pumps and wood heat may all be useful under certain circumstances and all are eligible for Federal government grants. In many cases, these three options would probably prove to be considerably more expensive than natural gas or electrical heat in urban areas. This need not be generally true. In rural areas, for example, where wood can be gathered at low marginal cost and used in modern air tight stoves or furnaces, it may be very economical. Heat pumps and solar heating systems normally involve very high capital costs, but these costs may fall significantly in future, making such options more attractive to the homeowner.

The reader should be cautioned that fuel prices, and especially materials and labor costs, will vary from one locale and situation to another. Therefore, the savings and payback periods may correspondingly vary from the results given in Table 4.1 and Tables B.1 - B.3. If fuel prices escalate faster than the low and high price scenarios given here, savings will be greater and thus, payback periods shorter. Likewise, if capital costs are lower than given here, the period will also be reduced.

4.6 Insulation Upgrading

Most of the housing stock in Canada built prior to the late 1970s was orginally fitted with a low or moderate level of thermal insulation. In an era of low, and sometimes declining, real energy prices, higher levels of insulation were not economically justified. The revolution in energy prices which took place during the 1970s and early 1980s has radically altered this fact. Real energy prices have increased rapidly. Further, oil prices are expected to continue rising faster than most other prices, so that greatly increased levels of insulation are economically justified in new and existing housing.

New housing built to 'super-energy efficient' standards may cost approximately 10 percent more than a comparable conventionally insulated house, but space heating bills will be reduced to about 25 percent of current levels. It is relatively easy to incorporate upgraded insulation into a new house design. It may be more difficult to upgrade existing housing to these 'super-efficient' standards, but there are options available to owners of existing houses which will considerably reduce heating costs.

The following sections have been designed to help the owner of a house insulated to the levels identified in Table 2.4 of Chapter 2 to upgrade to higher levels specified by Energy, Mines and Resources Canada (EMR) and by the National Research Council (NRC) of Canada.[4] Table 4.2 shows these values for various components of buildings and different degrees of climatic severity. Winnipeg, Regina and Edmonton lie in the 6,500 Celsius degree-days area (the second most severe), while all the rest of the selected cities, with the exception of Victoria and Vancouver, lie in the 5,000 Celsius degree day range. Victoria and Vancouver experience heating seasons of up to 3,500 Celsius degree-days (see Figure 4.4).

The seasonal heating loads and savings have been determined using the specific degree-days for the locales shown in Figure 4.2. The standards of insulation for the purposes of the upgrading analysis in this study are those standards recommended by EMR/NRC. These are shown in Tables 4.2a and 4.2b, and are contingent upon the severity of the winter heating season in a particular locale. It should be noted that these are now minimum acceptable standards. In areas with milder winter climates it is still economically justifiable to upgrade to the highest R value shown in the Tables: R40 for Ceilings and R20 for

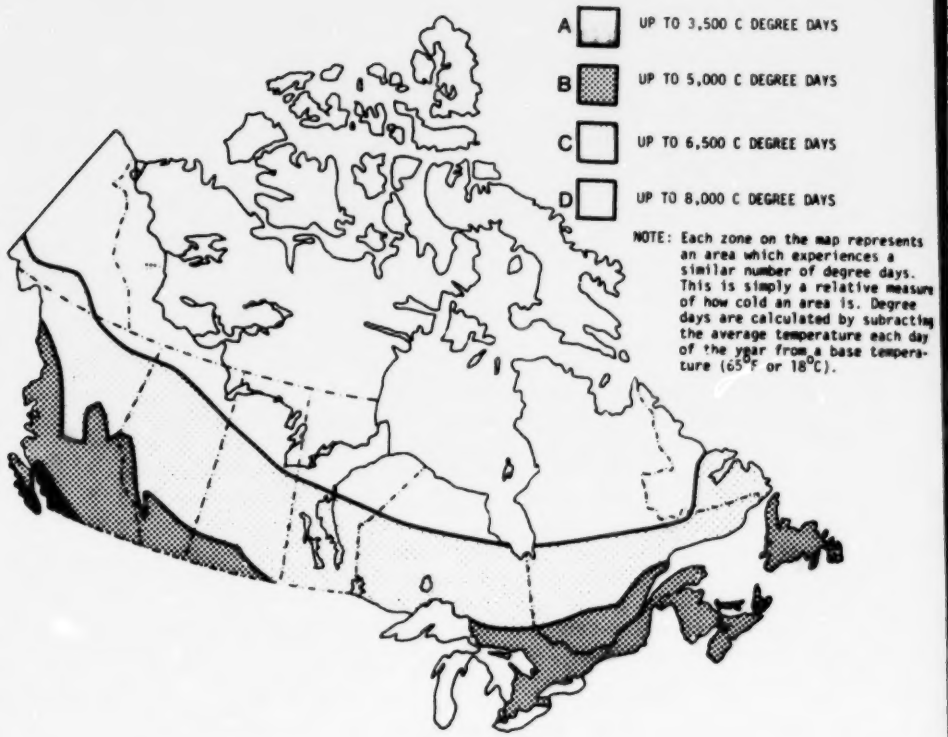
A
UP TO 3,500 C DEGREE DAYS
B
UP TO 5,000 C DEGREE DAYS
C
UP TO 6,500 C DEGREE DAYS
D
UP TO 8,000 C DEGREE DAYS
NOTE: Each zone on the map represents an area which experiences a similar number of degree days. This is simply a relative measure of how cold an area is. Degree days are calculated by subracting the average temperature each day of the year from a base temperature (65°F or 18°C).

FIGURE 4.4: DEGREE DAY MAP ZONES IN CANADA

TABLE 4.2a

NATIONAL RESEARCH COUNCIL CANADA AND ENERGY,
MINES AND RESOURCES CANADA
RECOMMENDED INSULATION LEVELS (R)[a]

Maximum Number of Fahrenheit Degree Days	Ceiling or Roof	Exterior Walls	Foundation Wall	Floor
Up to 6,318 (A)[b]	30	14	12	28
Up to 9,018 (B)[b]	32	17	12	28
Up to 11,718 (C)[b]	36	20	12	28
14 418 (D) and over[b]	40	21	12	28

SOURCE: Energy, Mines and Resources Canada, Keeping the Heat In, (Ottawa: EMR Canada, August 1976) and the National Research Council of Canada, Measures for Energy Conservation in New Buildings 1978, (Ottawa, NRC, 1978). The greater of the two insulation values from these two sources is given here.

[a]Windows: Storm windows, double-glazed windows with 1/4"-1/2" air space, or triple-glazed windows (in the colder regions of Canada).
Doors: Storm doors or an insulated wood or metal door at least 2" thick.

[b]See accompanying map.

TABLE 4.2b

NATIONAL RESEARCH COUNCIL CANADA AND ENERGY,
MINES AND RESOURCES CANADA
RECOMMENDED INSULATION LEVELS (RSI)

Maximum Number of Celsius Degree Days	Ceiling or Roof	Exterior Walls	Foundation Wall	Floor
Up to 3,500	5.3	2.5	2.1	4.9
Up to 5,000	5.6	3.0	2.1	4.9
Up to 6,500	6.3	3.5	2.1	4.9
Up to 8,000 and over	7.0	3.7	2.1	4.9

exterior walls. This procedure is generally recommended by most energy conservation agencies.

Among the options studied in this section, aside from the upgrading of insulation, is the upgrading of weatherstripping and caulking to reduce air changes per hour. Specifically, retrofitting options have been broken down into four different components. The first three are additions of insulation to the attic, the basement and the exterior walls of the house. The fourth involves caulking and weatherstripping and also the upgrading of single-glazed windows and doors, to those with either double-glazing or storm coverings. It should be noted at this point that, although weatherstripping and caulking have been included with upgrading windows and doors, tightening the house through weatherstripping and caulking are among the most cost-effective upgrading options open to the homeowner. For a cost of under $200 the homeowner can himself reduce the air infiltration rate of older houses to save 10 - 15 percent in fuel consumption. This effect has been well-documented.[5]

4.7 Ottawa Insulation Retrofit

For the representative city of Ottawa, the savings of upgrading insulation from low to high standards for all components and from minimum (1977 National Building Code Standards) to high standards (EMR/NRC) for attic and exterior wall components are shown in Tables 4.3 - 4.5 for the three housing types selected. Information pertinent to the other eleven cities in the sample is given in Tables B.4 - B.6 in Appendix B.

4.7.1 Attic Retrofit

In moving from a low to high level of attic insulation in the single-detached Ottawa house, approximately R-24 is added to existing insulation to produce a total R value of 34 at a capital cost of approximately $350. If oil is used for space heating, this results in a first year saving of $217 based on the most likely price scenario. If gas is used, the saving is $119 in the first year; $184 if electricity is used. The payback period for this investment in Ottawa is relatively short, ranging from two to five years depending upon the fuel used and whether a contractor is hired to do the job.

If the house is already fitted with a minimum level of attic insulation (approximately R14), upgrading to R34 will require the addition

TABLE 4.3

SPACE HEATING
OTTAWA - SINGLE-DETACHED

Option	Standards	Fuel	Installed Cost ($1981)		Savings in First Year ($1981)		Payback Period (years)			
							Owner		Contractor	
			Owner	Contractor	Low Price Scenario	High Price Scenario	Low Price Scenario	High Price Scenario	Low Price Scenario	High Price Scenario
ATTIC	Low to High	oil	400	600	217	217	2	2	3	3
		gas	400	600	119	119	3	3	5	5
		electricity	400	600	184	184	2	2	4	4
	Minimum to High	oil	350	525	111	111	3	3	5	5
		gas	350	525	60	60	5	5	9	8
		electricity	350	525	94	94	4	4	6	6
BASEMENT	Low to High	oil	450	900	439	439	2	2	2	2
		gas	450	900	248	248	2	2	4	4
		electricity	450	900	373	373	2	2	3	3
EXTERIOR WALLS	Low to High	oil	450	1 000	106	106	5	4	10	9
		gas	450	1 000	60	60	8	7	>10	>10
		electricity	450	1 000	90	90	6	6	>10	>10
	Minimum to High	oil	400	900	36	36	10	9	>10	>10
		gas	400	900	18	18	>10	>10	>10	>10
		electricity	400	900	31	31	>10	>10	>10	>10
WINDOWS, DOORS AND WEATHERSTRIPPING	Low to High	oil	1 200	2 500	156	156	8	7	>10	>10
		gas	1 200	2 500	87	87	>10	>10	>10	>10
		electricity	1 200	2 500	132	132	10	10	>10	>10
TOTAL	Low to High	oil	2 500	5 000	918	918	3	3	6	5
		gas	2 500	5 000	514	514	5	5	>10	9
		electricity	2 500	5 000	779	779	4	3	7	7

TABLE 4.4

SPACE HEATING
OTTAWA - SEMI-DETACHED

Option	Standards	Fuel	Installed Cost ($1981)		Savings in First Year ($1981)		Payback Period (years)			
							Owner		Contractor	
			Owner	Contractor	Low Price Scenario	High Price Scenario	Low Price Scenario	High Price Scenario	Low Price Scenario	High Price Scenario
ATTIC	Low to High	oil	200	300	113	113	2	2	3	3
		gas	200	300	64	64	3	3	6	5
		electricity	200	300	96	96	3	3	4	4
	Minimum to High	oil	175	275	56	56	3	3	6	5
		gas	175	275	32	32	5	5	10	4
		electricity	175	275	48	48	4	4	7	7
BASEMENT	Low to High	oil	250	500	240	240	2	2	3	3
		gas	250	500	133	133	2	2	4	4
		electricity	250	500	204	204	2	2	3	3
EXTERIOR WALLS	Low to High	oil	500	1 100	158	158	4	4	8	7
		gas	500	1 100	87	87	7	7	>10	>10
		electricity	500	1 100	134	134	5	5	10	10
	Minimum to High	oil	450	1 000	38	38	>10	>10	>10	>10
		gas	450	1 000	13	13	>10	>10	>10	>10
		electricity	450	1 000	33	33	>10	>10	>10	>10
WINDOWS, DOORS AND WEATHERSTRIPPING	Low to High	oil	1 000	2 200	160	160	7	6	>10	>10
		gas	1 000	2 200	87	87	>10	>10	>10	>10
		electricity	1 000	2 200	136	136	8	8	>10	>10
TOTAL	Low to High	oil	1 950	4 100	671	671	4	4	7	7
		gas	1 950	4 100	371	371	6	6	>10	>10
		electricity	1 950	4 100	570	570	5	5	9	9

TABLE 4.5

SPACE HEATING
OTTAWA - ROWHOUSE

Option	Standards	Fuel	Installed Cost ($1981)		Savings in First Year ($1981)		Payback Period (years)			
							Owner		Contractor	
			Owner	Contractor	Low Price Scenario	High Price Scenario	Low Price Scenario	High Price Scenario	Low Price Scenario	High Price Scenario
ATTIC	Low to High	oil	200	300	106	106	2	2	3	3
		gas	200	300	60	60	4	4	5	5
		electricity	200	300	90	90	3	3	4	4
	Minimum to High	oil	175	275	54	54	3	3	5	5
		gas	175	275	28	28	6	6	>10	>10
		electricity	175	275	46	46	4	4	7	7
BASEMENT	Low to High	oil	200	400	171	171	2	2	3	3
		gas	200	400	96	96	4	3	5	5
		electricity	200	400	146	146	3	3	4	4
EXTERIOR WALLS	Low to High	oil	300	650	97	97	3	3	6	5
		gas	300	650	55	55	6	5	10	9
		electricity	300	650	83	83	4	4	7	7
	Minimum to High	oil	275	600	27	27	8	7	>10	>10
		gas	275	600	14	14	>10	>10	>10	>10
		electricity	275	600	23	23	9	9	>10	>10
WINDOWS, DOORS AND WEATHERSTRIPPING	Low to High	oil	900	2 000	138	138	7	6	>10	>10
		gas	900	2 000	78	78	>10	>10	>10	>10
		electricity	900	2 000	117	117	9	9	>10	>10
TOTAL	Low to High	oil	1 600	3 350	512	512	3	3	6	6
		gas	1 600	3 350	289	289	6	5	>10	7
		electricity	1 600	3 350	436	436	4	4	8	8

of approximately R20 at an owner-installed cost of $300. The savings in the first year with oil heat are $111, $94 with electricity, and $60 with gas. Payback periods range from three to nine years.

The semi-detached house in the sample (see Table 4.4) is assumed to have a smaller ceiling area, therefore the costs of upgrading are lower and the total energy savings lower. Payback periods are, however, still short, ranging from two to six years. This is also generally true for the rowhouse (Table 4.5).

The reader should keep in mind that when the Federal CHIP grant is included in the calculations for qualifying homes, the payback will be considerably shortened.

4.8 Basement Upgrading

Although Table 2.4 shows that houses built to NBC 1977 standards (i.e. minimum) must have an R8.5 insulation level on foundation walls, in reality very few houses built prior to 1980 in any area of Canada will have any basement insulation at all. The relevant upgrading for the vast majority of houses will be from a low standard to a high standard, that is, the addition of R12 insulation. Typical concrete foundations are actually good conductors of heat energy. In areas where the ground surrounding the foundation freezes in winter, uninsulated basement walls are a source of considerable heat loss. The cost of providing R12 insulation on the inner surface of the foundation to a height of eight feet will, in most cases, be quickly paid back in energy savings.

Table 4.3 shows the benefit of making this investment for the single-detached house in Ottawa. If oil is used for heating, the savings in the first year will be $439. Even for the home heated with natural gas, savings are substantial at $248. If electricity is the heat source, savings will be $373. Materials cost to provide a stud framework and R12 insulation plus a thin drywall covering will be approximately $450. If the homeowner installs this material himself, the payback period will be two years. If it is contractor installed, the payback period may vary from two to four years. The results are similar for both the semi-detached and rowhouses in Ottawa. Generally speaking, for those houses already having some insulation, the best insulation investment homeowners across Canada can make is to insulate the foundation walls. Perusal of the tables in Appendix B will make this clear. In those areas of Canada which have a high number of

heating degree-days, such as Winnipeg and Regina, or where oil prices are very high, payback of the investment may take place as quickly as within one year.

4.9 Exterior Wall Insulation

The standards of exterior wall insulation given in Table 2.4 (R10 and R14 miminum) are now recognized as being inadequate. Much higher levels are economically justified with current energy prices, R17 being recommended as the minimum now acceptable in the Ottawa area. Unfortunately, upgrading the thermal resistance of exterior walls in existing housing can be a complex and difficult procedure. Most exterior frame walls built prior to 1980 are of standard 2" by 4" stud construction which actually provides a cavity only 3 5/8" (9.21 cm) deep in which to install insulation material. This normally allows only enough room to provide a total of R10 to R14 depending upon the type of insulation used. If the existing cavity is not completely filled, loose insulation can be poured or blown in through drilled holes without disturbing the interior or exterior cladding. However, this method will not produce the recommended higher level of R20. In order to obtain a level of R20, for example, the width of the wall must be increased. This, of course, raises the cost of upgrading the insulation value. The addition of R6 or R10 insulation can be done on the outside or the inside of the wall and will usually involve the addition of an extra frame structure (2" x 2", or 2" x 4") and new cladding such as siding on the outside or new gypsum board on the inside. Adding a new interior wall may cause considerable inconvenience and a space reduction in occupied housing, but may be the less expensive of the two options unless the exterior siding needs to be replaced anyway. There are various methods of increasing the thermal resistance of the wall structure, but no single option can be endorsed as being optional for all homes because of the variety of different materials and techniques used in original construction.

The cost estimates given in Tables 4.3 - 4.5 for Ottawa housing, and those in the appendix for this option, reflect an average cost of installing a 2" x 4" framework in the interior of the house, filling it with either R6 or R10 insulation to meet the R20 objective, adding a 6 mil air/vapor barrier, and covering it with new gypsum board on the inside.

The results of estimation of fuel cost savings and payback periods for upgrading walls from both low and minimum standards are

given in the tables. For the representative city of Ottawa, the first year low to high saving scenario for a single-detached house is $106 with oil, $90 with electricity and with natural gas heat, $60. Savings are not high enough, in all cases, to provide a rapid payback period. Under the minimum to high scenario the payback period is usually greater than 10 years.

The semi-detached house has the greatest net exposed wall area, therefore the savings are highest from upgrading the walls of this house type. The costs of upgrading are also greatest for this reason. Payback periods vary from only four years where oil heat is used and the homeowner does the work, to greater than ten years where natural gas is used and the labor is supplied by a contractor.

Upgrading the insulation of walls of the rowhouse, although assumed to be smaller, can provide a rapid payback of three years where oil heat is used. However, upgrading from the minimum to a high level still produces a relatively long payback period.

A perusal of the other cities in the sample given in Appendix B shows that, although the benefit of insulating walls is significant, payback periods of the investment are generally longer than those for upgrading attics and basements. This will not be the case if there is no insulation in the walls, as may be typical of some west-coast houses, or much of the pre-war or early post-war housing stock across the country.

4.10 Windows, Doors and Weatherstripping

The approach taken in this study has been to amalgamate the energy savings resulting from reducing the air changes per hour by weatherstripping and caulking the house, and those resulting from upgrading the windows and doors to high standards of thermal resistance. Reducing the amount of air transfer through caulking and tightening should actually be the first step in upgrading the home. This is a simple task which most homeowners can perform without difficulty and can result in savings of 10 to 15 percent. The materials cost of tightening a house the size of those identified in Table 2.4 may be as small as $100 to $200. It should be noted that reducing the air changes per hour reduces exfiltration of warm inside air and is not the same as upgrading insulation. Air tightening is complementary to upgrading insulation because it reduces the movement of water vapor generated in the house through the inside wall and into the insulation

itself, which is a highly undesirable situation. Weatherstripping doors and windows reduces the exchange of cold air for heated air which otherwise adds to the heating load.

The most expensive part of the upgrading package suggested here is the upgrading of the windows and doors themselves. Table 2.4 suggests that houses insulated to a low level will have single-glazed windows with no storm windows. Doors will also be uninsulated solid single units. Reducing the conductive loss through these components requires that they be replaced entirely with new units meeting the new insulation specifications, or that storm windows and doors be installed. Under the minimum level scenario, double glazing or storm windows already exist. The installation of triple-glazed windows was not included in the analysis because of the high initial cost, although they may be economically justified in colder areas of Canada.

Estimates of the Ottawa costs, first year savings and payback periods for heat conservation measures of this type are shown in Tables 4.3 - 4.5. In general, outlays for these will be paid back over a much longer period of time than attic, basement and exterior wall insulation investments. However, this is not the case for simple weatherstripping and caulking alone. Estimates of the costs, savings and payback periods are shown in Tables B.4 - B.36 for this option for all other cities in the sample.

4.11 Total Component Package

The insulation retrofit options shown individually in Tables 4.3 - 4.5 and in the appendix can be implemented individually as financial resources permit, or as a package. The costs of implementing the package and the total savings and payback periods are given at the bottom of the tables. In most cases, the payback periods are well under ten years.

The entire package as suggested here need not be implemented all at once. Those options which are paid back the fastest can be implemented first and the energy savings which result applied to the next most desirable option.

It should be noted that while energy savings within the insulation package are additive, the savings resulting from switching to a cheaper heating fuel cannot simply be added to the insulation related savings estimate if conversion is made at the same time as

reinsulation. This is because the total heating load will be smaller after insulation, such that the gains from furnace retrofit will be less.

4.11.1 Basic Conservation Measures: Space Heating

Although the largest reductions in household space heating costs will result from substituting other energy forms for fuel oil and from the addition of insulation to the external shell structure, considerable savings can be realized by implementing other less complex measures. One very simple way of reducing the heating load is to reduce the house ambient temperature during the day and even further during the nighttime hours. Reducing the temperature differential between the outside atmosphere and the inside will reduce the speed of heat energy conductance. This can be done manually by reducing daytime temperatures from the average 22.2°C (72°F) to 20°C (68°F), without causing, in most cases, discomfort. Nighttime temperatures can be reduced to 17°C (63°F).[6] If this is done consistently, energy savings can and will continue to be produced as shown in Table 4.6 for one Ottawa housing type. An alternative is to install an automatic setback thermostat which will set the temperature back at night without the homeowner having to remember to do so. This type of thermostat is quite simple to install and should not present any difficulty for the handyman. It will provide the consistent control necessary to produce the savings shown in Tables 4.6, 4.7 and 4.8. If a contractor installs the thermostat the payback period for the investment will be slightly longer, but not greater than six years in Ottawa. With oil heat, this payback period will be reduced considerably. The larger the heating load, of course, the greater will be the savings resulting from thermostat setback. The savings for sample cities other than Ottawa, for all three house types, are given in Appendix B, Tables B.37 - B.69.

4.12 Energy Conservation in Water Heating

The water heating appliance is the second largest single user of energy in most households after the space heating plant. The annual cost of operating this appliance can be reduced significantly by applying the same methods used in the above section dealing with space heating.

TABLE 4.6

ENERGY SAVINGS FROM THERMOSTAT SETBACK
OTTAWA - SINGLE-DETACHED
(1981 dollars)

Option	Fuel	Capital Cost	Savings in First Year			Payback Period (years)		
			Insulation Standards			Insulation Standards		
			Low	Minimum	High	Low	Minimum	High
Manual thermostat setback	oil	0	134	74	53	..... Immediate		
	gas		78	41	32	..... Immediate		
	electricity		123	66	48	..... Immediate		
Automatic thermostat setback (owner installed)	oil	90	134	74	53	1	2	2
	gas		78	41	32	2	3	3
	electricity		123	66	48	1	2	2
Automatic thermostat (contractor installed)	oil	130	134	74	53	1	2	3
	gas		78	41	32	2	4	4
	electricity		123	66	48	2	3	3

Note: Daytime temperatures reduced from 22.2°C to 20°C. Nighttime temperatures are reduced to 17°C.

TABLE 4.7

ENERGY SAVINGS FROM THERMOSTAT SETBACK
OTTAWA - SEMI-DETACHED
(1981 dollars)

Option	Fuel	Capital Cost	Savings in First Year			Payback Period (years)		
			Insulation Standards			Insulation Standards		
			Low	Minimum	High	Low	Minimum	High
Manual thermostat setback	oil	0	109	64	48	.....	Immediate	.....
	gas		60	37	28	.....	Immediate	.....
	electricity		100	56	44	.....	Immediate	.....
Automatic thermostat setback (owner installed)	oil	90	109	64	48	1	2	2
	gas		60	37	28	2	3	4
	electricity		100	56	44	1	2	3
Automatic thermostat (contractor installed)	oil	130	109	64	48	2	2	3
	gas		60	37	28	3	4	5
	electricity		100	56	44	2	3	4

Note: Daytime temperatures reduced from 22.2°C to 20°C. Nighttime temperatures are reduced to 17°C.

TABLE 4.8

ENERGY SAVINGS FROM THERMOSTAT SETBACK
OTTAWA - ROWHOUSE
(1981 dollars)

Option	Fuel	Cost	Savings in First Year			Payback Period (years)		
			Insulation Standards			Insulation Standards		
			Low	Minimum	High	Low	Minimum	High
Manual thermostat setback	oil	0	87	52	39	.....	Immediate	.....
	gas		50	28	23	.....	Immediate	.....
	electricity		80	46	36	.....	Immediate	.....
Automatic thermostat setback (owner installed)	oil	90	87	52	39	2	2	3
	gas		50	28	23	2	4	4
	electricity		80	46	36	2	3	3
Automatic thermostat (contractor installed)	oil	130	87	52	39	2	3	4
	gas		50	28	23	3	5	6
	electricity		80	46	36	2	3	4

Note: Daytime temperatures reduced from 22.2°C to 20°C. Nighttime temperatures are reduced to 17°C.

4.12.1 Alternative Fuel Use

In many areas of Canada fuel oil is still used to heat water. As fuel oil prices continue to rise in real terms, taking no conservation action becomes expensive. Where natural gas is available, oil to gas conversion is clearly the lowest cost option. In most cases, heating water with electricity is slightly more expensive than with gas. Table 4.9 shows estimates of the replacement cost of water heaters using energy sources other than oil for all cities.

Switching from oil to natural gas produces first year savings from as high as $153 in Regina to $96 in Montreal. Switching to electricity shows savings from $20 in Saint John to $82 in Winnipeg. Only in Halifax was electrical hot water heating more expensive than fuel oil. Payback periods for conservation investments range from as short as one year to as long as four years. If a hot water tank must be replaced due to corrosion, it is preferable to replace one using fuel oil with a natural gas-powered tank or, if gas is unavailable, with an electrically heated tank. Halifax is the only exception to this rule among the sample cities (if Charlottetown were included it would be another). If the original heater has some residual scrap value, then the payback period would be correspondingly shorter.

4.12.2 Thermal Retrofit of Water Tanks

It is evident that the standby losses of conventional water heater tanks can be considerable. For this reason, some manufacturers are now offering tanks with higher levels of insulation. This will further reduce operating costs by reducing energy requirements. Homeowners can easily upgrade the level of insulation of their tanks by wrapping a layer of fiberglass or other insulation material around the outside of the tank. Table 4.10 shows the benefits which can be gained by adding a layer of R10 insulation to the tank (at a cost of approximately $8). In all cities, this small investment pays back in two years or less. This addition will, of course, marginally reduce the 'free heat' available for space heating purposes. The reader should remember that, generally speaking, the lower the energy requirement, the smaller will be the savings resulting from switching to a less expensive fuel.

4.12.3 Basic Conservation Measures

Other options exist which could help reduce household energy costs. These basic measures all tend to reduce the demand for energy

TABLE 4.9

CONVERSION TO AN ALTERNATE WATER HEATING FUEL

City	Conversion Options	Capital Cost (1981$)	Savings in First Year (1981$)	Payback Period (years)	
				Low Price	High Price
Victoria	Oil to Electricity	210	47	4	2
Vancouver	Oil to Natural Gas	190	144	2	1
	Oil to Electricity	210	47	4	2
Regina	Oil to Natural Gas	190	153	2	2
	Oil to Electricity	210	67	4	3
Winnipeg	Oil to Natural Gas	190	133	2	2
	Oil to Electricity	210	82	3	2
Toronto	Oil to Natural Gas	190	111	2	2
	Oil to Electricity	210	39	4	3
Ottawa	Oil to Natural Gas	190	111	2	2
	Oil to Electricity	210	39	4	3
Montreal	Oil to Natural Gas	190	96	3	2
	Oil to Electricity	210	71	3	3
Saint John	Oil to Electricity	210	20	4	3
St. John's	Oil to Electricity	210	51	4	4
Halifax	Oil to Electricity	210	-62		

TABLE 4.10

THERMAL RETROFIT - DOMESTIC HOT WATER HEATING
(additional water tank insulation)

City	Fuel	Capital Cost (1981 $)	Savings in First Year (1981 $)	Payback Period (years)
Victoria/Vancouver	oil		11	1
	gas	8	5	2
	electricity		10	1
Calgary/Edmonton	gas	8	4	2
Winnipeg	oil		11	1
	gas	8	5	2
	electricity		8	1
Toronto/Ottawa	oil		11	1
	gas	8	6	2
	electricity		10	1
Montreal	oil		11	1
	gas	8	7	2
	electricity		9	1
Saint John	oil		11	1
	electricity	8	11	1
St. John's	oil		12	1
	electricity	8	11	1
Halifax	oil		11	1
	electricity	8	15	1

by reducing both the demand for and temperature of hot water. Manual reduction of the temperature setting control by 10°C can produce an annual saving of $31 in the first year in Ottawa as shown in Table 4.11. The installation of volume restrictors and flow controls, such as those referred to in Table 4.11, may produce payback periods of less than one year. Tables C.1 - C.11 show the results of using these devices in the other eleven cities of the sample. In most cases, the payback period is less than one year. It should be noted that this is not an exhaustive list of all conservation or cost reduction techniques which can be applied to the hot water system. Larger amounts of insulation can be used, heat traps to prevent convection losses can be installed and more efficient condensing burners are now available which provide greatly increased fuel conversion efficiencies.

4.13 Conclusion

The first three chapters of this study have identified and quantified the major sources of household energy costs for three housing types in twelve Canadian cities. Chapter 4 has identified a variety of ways by which these energy costs can be reduced through conservation and fuel substitution. As energy costs continue to increase in real terms in the near future, implementing the many options discussed in Chapter 4 will become very attractive to most homeowners.

The major objective of this study has been to provide house owners with information about the monetary value of reducing energy consumption in their homes and to outline a framework within which the savings and payback periods could be evaluated. The reader who has carefully studied the results provided in the tables should be impressed with the monetary benefits produced by most of the options.

It should be remembered that the Government of Canada and various provincial agencies provide subsidies for upgrading of insulation levels (although not in all cases) and for conversion of the household heating plant from oil to other sources. These grants will reduce the investment cost to the homeowner and shorten the payback period further in many cases. Because many of these subsides are taxable, their effect on payback periods varies with homeowners' marginal income tax rates. For this reason, such grants were excluded from the calculations.

Homeowners who make calculations based on specific information about their own house, locale and energy prices may find that some

TABLE 4.11

CONSERVATION MEASURES - DOMESTIC HOT WATER HEATING
OTTAWA

Option	Fuel	Capital Cost (1981$)	Savings in First Year (1981$)	Payback Period (years)
Manual thermostat setback	oil	0	31	Immediate
	gas		19	Immediate
	electricity		26	Immediate
Shower:				
Flow restrictor	oil	3-4	29	1
	gas		17	1
	electricity		27	1
Adjustable volume control	oil	8-12	29	1
	gas		17	1
	electricity		27	1
Faucet:				
Flow restrictor	oil	1-3	10	1
	gas		6	1
	electricity		9	1
Aerator	oil	5-7	10	1
	gas		6	1-2
	electricity		9	1
Spray Tap	oil	8-10	10	1
	gas		6	1-2
	electricity		9	1-2

discrepancy exists between their results and the results given here. This is not unexpected. A comprehensive analysis such as this must rely on general cost information, such as average energy prices. This tends to smooth out intra-province price and cost variations. On balance, however, most of the conservation and substitution options discussed are obviously attractive.

This document has been designed to report monetary benefits and costs rather than technical information required by homeowners installing materials and equipment themselves. For this reason it is recommended that homeowners who contemplate doing the work themselves refer to such technical documents as Energy, Mines and Resources Canada's, Keeping the Heat In or the Canadian Mortgage and Housing Corporation's, The Conservation of Energy in Housing. Both documents provide a wealth of technical information required to make the conservation and substitution options suggested here a success. Most provincial government energy departments or their equivalents also offer published information on these types of options. The reader should consult some of these sources before undertaking projects. For those homeowners who will enlist the services of a qualified contractor, the above mentioned sources of information will provide details to help them ensure that the contractor carries out the work to an acceptable level of quality.

Footnotes

[1]Canadian Enerdata Limited, Canadian Energy Trends: Quarterly Data Base Management, Analysis and Outlook, (Canadian Enerdata Ltd: Willowdale, Ontario, Vol. I, No. 4, May 1982).

[2]Ibid.

[3]Canada Mortgage and Housing Corporation, The Conservation of Energy in Housing, (Ottawa: Canada Mortgage and Housing Corporation, 1981), p. 36.

[4]Energy, Mines and Resources Canada (EMR), Keeping the Heat In, (Ottawa: Energy, Mines and Resources Canada, August, 1976), p. 34; National Rearch Council of Canada, Measures for Energy Conservation in New Buildings, (Ottawa: National Research Council, 1978).

[5]Energy, Mines and Resources Canada, op. cit., p. 81.

[6]Ibid., p. 88.

APPENDIX A

FUEL PRICES

TABLE A.1

FUEL PRICES
VANCOUVER/VICTORIA

Years	Most likely case			High Case	
	Light Fuel Oil ($/litre)	Natural Gas[a] ($/m^3)	Electricity ($/kw.h)	Light Fuel Oil ($/litre)	Natural Gas[a] ($/m^3)
1981	.2442	.1228	.0309	.2442	.1228
1982	.2926	.1747	.0333	.3079	.1850
1983	.3410	.2050	.04	.3762	.2263
1984	.3806	.2273	.0468	.4443	.2672
1985	.4245	.2527	.0533	.5125	.3075
1986	.4729	.2813	.0586	.5807	.3484
1987	.5301	.3149	.0645	.6599	.3968
1988	.5939	.3519	.0709	.7369	.4427
1989	.6643	.3940	.078	.8073	.4836
1990	.7435	.4409	.0858	.9106	.5461

[a]Vancouver only - natural gas is not yet available in Victoria.

TABLE A.2

FUEL PRICES
CALGARY/EDMONTON

Years	Most likely case			High Case	
	Light Fuel Oil ($/litre)	Natural Gas ($/m^3)	Electricity ($/kw.h)	Light Fuel Oil ($/litre)	Natural Gas ($/m^3)
1981	.2353	.1041	.0291	.2353	.1041
1982	.2860	.1645	.0341	.3036	.1744
1983	.3366	.1934	.0385	.3718	.2146
1984	.3762	.2143	.0435	.4399	.2545
1985	.4201	.2386	.0492	.5059	.2930
1986	.4663	.2655	.0556	.5741	.3329
1987	.5235	.2972	.0612	.6533	.3795
1988	.5873	.3329	.0673	.7303	.4236
1989	.6555	.4081	.074	.7985	.4628
1990	.7347	.4176	.0814	.9019	.5231

TABLE A.3

FUEL PRICES
REGINA

Years	Most likely case			High Case	
	Light Fuel Oil ($/litre)	Natural Gas ($/m^3)	Electricity ($/kw.h)	Light Fuel Oil ($/litre)	Natural Gas ($/m^3)
1981	.2439	.1073	.0272	.2398	.1073
1982	.2903	.1747	.034	.3058	.1850
1983	.3409	.2051	.0384	.3740	.2263
1984	.3784	.2273	.0434	.4421	.2672
1985	.4245	.2528	.0491	.5103	.3074
1986	.4707	.2810	.0554	.5785	.3484
1987	.5279	.3145	.061	.6599	.3968
1988	.5917	.3520	.0671	.7347	.4427
1989	.6621	.3940	.0738	.8051	.4836
1990	.7413	.4409	.0812	.9084	.5461

TABLE A.4

FUEL PRICES
WINNIPEG

Years	Most likely case			High Case	
	Light Fuel Oil ($/litre)	Natural Gas ($/m^3)	Electricity ($/kw.h)	Light Fuel Oil ($/litre)	Natural Gas ($/m^3)
1981	.2420	.1327	.0253	.2420	.1327
1982	.2926	.1850	.0253	.3101	.1949
1983	.3432	.2160	.0253	.3783	.2372
1984	.3828	.2397	.0253	.4465	.2796
1985	.4289	.2669	.0304	.5147	.3212
1986	.4751	.2965	.0364	.5829	.3640
1987	.5323	.3315	.0401	.6643	.4134
1988	.5961	.3707	.0441	.7413	.4610
1989	.6687	.4140	.0485	.8095	.5041
1990	.7479	.4631	.0533	.9150	.5683

TABLE A.5

FUEL PRICES
TORONTO/OTTAWA

Years	Most likely case			High Case	
	Light Fuel Oil ($/litre)	Natural Gas ($/m^3)	Electricity ($/kw.h)	Light Fuel Oil ($/litre)	Natural Gas ($/m^3)
1981	.2464	.1620	.0324	.2464	.1620
1982	.2970	.1949	.0355	.3124	.2047
1983	.3476	.2273	.0401	.3806	.2486
1984	.3872	.2520	.0465	.4487	.2923
1985	.4311	.2806	.054	.5191	.3350
1986	.4795	.3117	.0615	.5873	.3791
1987	.5367	.3481	.0677	.6687	.4303
1988	.6027	.3891	.0745	.7457	.4797
1989	.6731	.4345	.0819	.8161	.5246
1990	.7523	.4853	.0901	.9217	.5909

TABLE A.6

FUEL PRICES
MONTREAL

Years	Most likely case			High Case	
	Light Fuel Oil ($/litre)	Natural Gas ($/m^3)	Electricity ($/kw.h)	Light Fuel Oil ($/litre)	Natural Gas ($/m^3)
1981	.2485	.1810	.028	.2486	.1810
1982	.2969	.2330	.0327	.3124	.2429
1983	.3475	.2697	.0373	.3806	.2909
1984	.3871	.2994	.0425	.4509	.3392
1985	.4311	.3332	.0484	.5191	.3876
1986	.4795	.3696	.0533	.5873	.4370
1987	.5389	.4116	.0586	.6687	.4939
1988	.6027	.4593	.0645	.7457	.5500
1989	.6731	.5119	.0709	.8161	.6019
1990	.7545	.5701	.078	.9217	.6757

TABLE A.7

FUEL PRICES
SAINT JOHN

Years	Most likely case			High Case	
	Light Fuel Oil ($/litre)	Natural Gas ($/m^3)	Electricity ($/kw.h)	Light Fuel Oil ($/litre)	Natural Gas ($/m^3)
1981	0	.1980	.0353	.2464	0
1982	0	.2408	.0336	.3124	0
1983	0	.2782	.0383	.3805	0
1984	0	.3085	.0437	.4509	0
1985	0	.3435	.0498	.5191	0
1986	0	.3809	.0548	.5873	0
1987	0	.4243	.0602	.6687	0
1988	0	.4734	.0663	.7457	0
1989	0	.5278	.0729	.8161	0
1990	0	.5871	.0802	.9217	0

TABLE A.8

FUEL PRICES
ST. JOHN'S

Years	Most likely case			High Case	
	Light Fuel Oil ($/litre)	Natural Gas ($/m^3)	Electricity ($/kw.h)	Light Fuel Oil ($/litre)	Natural Gas ($/m^3)
1981	.2618	0	.033	.2617	0
1982	.2970	0	.0375	.3123	0
1983	.3476	0	.0424	.3805	0
1984	.3871	0	.0479	.4509	0
1985	.4311	0	.0541	.5191	0
1986	.4795	0	.0611	.5873	0
1987	.5389	0	.0673	.6687	0
1988	.6027	0	.074	.7457	0
1989	.6731	0	.0814	.8161	0
1990	.7545	0	.0895	.9217	0

TABLE A.9

FUEL PRICES
HALIFAX

Years	Most likely case			High Case	
	Light Fuel Oil ($/litre)	Natural Gas ($/m^3)	Electricity ($/kw.h)	Light Fuel Oil ($/litre)	Natural Gas ($/m^3)
1981	.2442	0	.0471	.2441	0
1982	.2970	0	.0471	.3123	0
1983	.3476	0	.0523	.3805	0
1984	.3872	0	.058	.4509	0
1985	.4092	0	.0644	.5191	0
1986	.4795	0	.0715	.5873	0
1987	.5389	0	.0787	.6687	0
1988	.6027	0	.0865	.7457	0
1989	.6731	0	.0952	.8161	0
1990	.7545	0	.1047	.9217	0

APPENDIX B

COSTS, BENEFITS AND PAYBACK PERIODS FOR SPACE HEATING OPTIONS

TABLE B.1

CONVERSION TO AN ALTERNATE SPACE HEATING FUEL
SINGLE-DETACHED

City	Conversion Options	Capital Cost ($1981)	Savings in First Year ($1981)		Payback Period (years)			
					Low Insulation		Minimum Insulation	
			Low Insulation	Minimum Insulation	Low Price Scenario	High Price Scenario	Low Price Scenario	High Price Scenario
Victoria	Oil to Electricity	2 500	184	91	>10	5	>10	10
Vancouver	Oil to Natural Gas	1 400	550	269	3	2	6	4
	Oil to Natural Gas	700	550	269	2	1	3	2
	Oil to Electricity	2 500	179	88	>10	5	>10	10
Regina	Oil to Natural Gas	1 400	1 274	557	2	2	3	3
	Oil to Natural Gas	700	1 274	557	1	1	2	2
	Oil to Electricity	2 500	557	244	5	4	>10	7
Winnipeg	Oil to Natural Gas	1 400	1 100	476	2	2	4	3
	Oil to Natural Gas	700	1 100	476	1	1	2	2
	Oil to Electricity	2 500	682	296	3	3	6	5
Toronto	Oil to Natural Gas	1 400	610	249	3	3	6	5
	Oil to Natural Gas	700	610	249	2	2	3	3
	Oil to Electricity	2 500	214	88	9	6	>10	>10
Ottawa	Oil to Natural Gas	1 400	710	313	2	2	5	5
	Oil to Natural Gas	700	710	313	1	1	3	3
	Oil to Electricity	2 500	252	111	8	5	>10	>10
Montreal	Oil to Natural Gas	1 400	568	288	3	3	6	5
	Oil to Natural Gas	700	568	288	2	2	3	3
	Oil to Electricity	2 500	421	219	6	5	>10	8
Saint John	Oil to Electricity	2 500	129	56	7	5	>10	9
St. John's	Oil to Electricity	2 500	338	172	8	5	>10	9
Halifax	Oil to Electricity	2 500	-343	-171	-10	-10	-10	-10

TABLE 8.2

CONVERSION TO AN ALTERNATE SPACE HEATING FUEL
SEMI-DETACHED

City	Conversion Options	Capital Cost ($1981)	Savings in First Year ($1981)		Payback Period (years)			
			Low Insulation	Minimum Insulation	Low Insulation		Minimum Insulation	
					Low Price Scenario	High Price Scenario	Low Price Scenario	High Price Scenario
Victoria	Oil to Electricity	2 500	141	76	>10	6	>10	>10
Vancouver	Oil to Natural Gas	1 400	421	223	4	3	7	5
	Oil to Natural Gas	700	421	223	2	2	4	3
	Oil to Electricity	2 500	138	73	>10	7	>10	>10
Regina	Oil to Natural Gas	1 400	1 010	475	2	2	4	4
	Oil to Natural Gas	700	1 010	475	1	1	2	2
	Oil to Electricity	2 500	444	208	6	5	>10	8
Winnipeg	Oil to Natural Gas	1 400	871	406	2	2	4	4
	Oil to Natural Gas	700	871	406	1	1	2	2
	Oil to Electricity	2 500	540	252	4	3	7	6
Toronto	Oil to Natural Gas	1 400	474	209	3	3	7	6
	Oil to Natural Gas	700	474	209	2	2	4	4
	Oil to Electricity	2 500	167	74	>10	7	>10	>10
Ottawa	Oil to Natural Gas	1 400	556	257	3	3	6	5
	Oil to Natural Gas	700	556	257	2	2	3	3
	Oil to Electricity	2 500	197	90	10	6	>10	>10
Montreal	Oil to Natural Gas	1 400	444	201	4	4	8	7
	Oil to Natural Gas	700	444	201	2	2	4	4
	Oil to Electricity	2 500	330	149	8	6	>10	>10
Saint John	Oil to Electricity	2 500	101	46	8	6	>10	>10
St. John's	Oil to Electricity	2 500	265	147	10	6	>10	>10
Halifax	Oil to Electricity	2 500	-268	-146	-10	-10	-10	-10

TABLE B.3

CONVERSION TO AN ALTERNATE SPACE HEATING FUEL
ROWHOUSE

City	Conversion Options	Capital Cost ($1981)	Savings in First Year ($1981)		Payback Period (years)			
			Low Insulation	Minimum Insulation	Low Insulation		Minimum Insulation	
					Low Price Scenario	High Price Scenario	Low Price Scenario	High Price Scenario
Victoria	Oil to Electricity	2 500	111	53	>10	8	>10	>10
Vancouver	Oil to Natural Gas	1 400	310	157	5	4	>10	7
	Oil to Natural Gas	700	310	157	3	2	5	4
	Oil to Electricity	2 500	101	51	>10	9	>10	>10
Regina	Oil to Natural Gas	1 400	782	359	2	2	5	5
	Oil to Natural Gas	700	782	359	1	1	3	3
	Oil to Electricity	2 500	342	157	8	6	>10	>10
Winnipeg	Oil to Natural Gas	1 400	673	307	3	3	5	5
	Oil to Natural Gas	700	673	307	2	2	3	3
	Oil to Electricity	2 500	416	191	5	4	9	7
Toronto	Oil to Natural Gas	1 400	362	152	4	4	10	8
	Oil to Natural Gas	700	362	152	2	2	5	5
	Oil to Electricity	2 500	127	54	>10	9	>10	>10
Ottawa	Oil to Natural Gas	1 400	427	189	4	3	8	7
	Oil to Natural Gas	700	427	189	2	2	4	4
	Oil to Electricity	2 500	150	67	>10	8	>10	>10
Montreal	Oil to Natural Gas	1 400	338	146	5	5	>10	9
	Oil to Natural Gas	700	338	146	3	3	6	5
	Oil to Electricity	2 500	252	109	10	7	>10	>10
Saint John	Oil to Electricity	2 500	78	34	10	7	>10	>10
St. John's	Oil to Electricity	2 500	203	117	>10	8	>10	>10
Halifax	Oil to Electricity	2 500	-204	-112	-10	-10	-10	-10

TABLE B.4

SPACE HEATING
VICTORIA - SINGLE-DETACHED

Option	Standards	Fuel	Installed Cost ($1981)		Savings in First Year ($1981)		Payback Period (years)			
			Owner	Contractor	Low Price Scenario	High Price Scenario	Owner		Contractor	
							Low Price Scenario	High Price Scenario	Low Price Scenario	High Price Scenario
ATTIC	Low to High	oil	400	600	144	180	3	2	4	3
		electricity	400	600	116	116	4	3	5	5
	Minimum to High	oil	350	525	91	115	4	3	6	5
		electricity	350	525	75	175	5	5	7	7
BASEMENT	Low to High	oil	450	900	289	364	2	2	3	3
		electricity	450	900	235	235	2	2	4	4
EXTERIOR WALLS	Low to High	oil	450	1 000	53	67	9	7	>10	>10
		electricity	450	1 000	43	43	>10	>10	>10	>10
	Minimum to High	oil	400	900	24	31	>10	>10	>10	>10
		electricity	400	900	21	21	>10	>10	>10	>10
WINDOWS, DOORS AND WEATHERSTRIPPING	Low to High	oil	1 200	2 500	102	129	>10	9	>10	>10
		electricity	1 200	2 500	83	83	>10	>10	>10	>10
TOTAL	Low to High	oil	2 500	5 000	588	740	5	4	10	9
		electricity	2 500	5 000	477	477	5	6	>10	>10

TABLE B.5

SPACE HEATING
VANCOUVER - SINGLE-DETACHED

Option	Standards	Fuel	Installed Cost ($1981)		Savings in First Year ($1981)		Payback Period (years)			
			Owner	Contractor	Low Price Scenario	High Price Scenario	Owner		Contractor	
							Low Price Scenario	High Price Scenario	Low Price Scenario	High Price Scenario
ATTIC	Low to High	oil	400	600	139	175	3	2	5	4
		gas	400	600	60	60	6	7	10	10
		electricity	400	600	115	115	3	3	6	4
	Minimum to High	oil	350	525	89	112	4	3	5	5
		gas	350	525	38	38	7	6	>10	10
		electricity	350	525	73	73	5	5	8	8
BASEMENT	Low to High	oil	450	900	282	356	2	2	3	3
		gas	450	900	122	122	4	4	7	6
		electricity	450	900	230	230	2	2	4	4
EXTERIOR WALLS	Low to High	oil	450	1 000	51	64	10	7	>10	>10
		gas	450	1 000	21	21	>10	>10	>10	>10
		electricity	450	1 000	42	42	>10	>10	>10	>10
	Minimum to High	oil	400	900	24	31	>10	>10	>10	>10
		gas	400	900	10	10	>10	>10	>10	>10
		electricity	400	900	20	20	>10	>10	>10	>10
WINDOWS, DOORS AND WEATHERSTRIPPING	Low to High	oil	1 200	2 500	99	125	>10	10	>10	>10
		gas	1 200	2 500	42	42	>10	>10	>10	>10
		electricity	1 200	2 500	81	81	>10	>10	>10	>10
TOTAL	Low to High	oil	2 500	5 000	571	720	5	4	10	8
		gas	2 500	5 000	245	245	>10	>10	>10	>10
		electricity	2 500	5 000	468	468	7	6	>10	>10

TABLE 8.6

SPACE HEATING
CALGARY - SINGLE-DETACHED

Option	Standards	Fuel	Installed Cost ($1981)		Savings in First Year ($1981)		Payback Period (years)			
							Owner		Contractor	
			Owner	Contractor	Low Price Scenario	High Price Scenario	Low Price Scenario	High Price Scenario	Low Price Scenario	High Price Scenario
ATTIC	Low to High	gas	400	600	94	94	3	3	5	5
	Minimum to High	gas	350	525	44	44	6	5	9	8
BASEMENT	Low to High	gas	450	900	180	180	3	3	4	4
EXTERIOR WALLS	Low to High	gas	450	1 000	56	56	7	6	>10	>10
	Minimum to High	gas	400	900	15	15	>10	>10	>10	>10
WINDOWS, DOORS AND WEATHERSTRIPPING	Low to High	gas	1 200	2 500	67	67	>10	>10	>10	>10
TOTAL	Low to High	gas	2 500	5 000	397	397	6	6	>10	9

TABLE B.7

SPACE HEATING
EDMONTON - SINGLE-DETACHED

Option	Standards	Fuel	Installed Cost ($1981)		Savings in First Year ($1981)		Payback Period (years)			
							Owner		Contractor	
			Owner	Contractor	Low Price Scenario	High Price Scenario	Low Price Scenario	High Price Scenario	Low Price Scenario	High Price Scenario
ATTIC	Low to High	gas	400	600	97	97	3	3	5	5
	Minimum to High	gas	350	525	44	44	6	5	9	8
BASEMENT	Low to High	gas	450	900	189	189	2	2	4	4
EXTERIOR WALLS	Low to High	gas	450	1 000	59	59	6	6	>10	>10
	Minimum to High	gas	400	900	18	18	>10	>10	>10	>10
WINDOWS, DOORS AND WEATHERSTRIPPING	Low to High	gas	1 200	2 500	65	65	>10	>10	>10	>10
TOTAL	Low to High	gas	2 500	5 000	410	410	5	5	10	9

TABLE B.8

SPACE HEATING
REGINA - SINGLE-DETACHED

Option	Standards	Fuel	Installed Cost ($1981)		Savings in First Year ($1981)		Payback Period (years)			
							Owner		Contractor	
			Owner	Contractor	Low Price Scenario	High Price Scenario	Low Price Scenario	High Price Scenario	Low Price Scenario	High Price Scenario
ATTIC	Low to High	oil	400	600	279	279	2	2	2	2
		gas	400	600	106	106	3	3	4	4
		electricity	400	600	204	204	2	2	3	3
	Minimum to High	oil	350	525	131	131	3	3	4	4
		gas	350	525	49	49	5	5	8	7
		electricity	350	525	96	96	3	3	5	5
BASEMENT	Low to High	oil	450	900	538	538	1	1	2	2
		gas	450	900	207	207	2	2	4	4
		electricity	450	900	394	394	2	2	3	3
EXTERIOR WALLS	Low to High	oil	450	1 000	172	172	3	3	6	6
		gas	450	1 000	67	67	6	5	>10	10
		electricity	450	1 000	127	127	4	4	8	8
	Minimum to High	oil	400	900	50	50	7	1	>10	>10
		gas	400	900	18	18	>10	>10	>10	>10
		electricity	400	900	37	37	10	10	>10	>10
WINDOWS, DOORS AND WEATHERSTRIPPING	Low to High	oil	1 200	2 500	190	190	6	6	>10	>10
		gas	1 200	2 500	73	73	>10	>10	>10	>10
		electricity	1 200	2 500	139	139	9	9	>10	>10
TOTAL	Low to High	oil	2 500	5 000	1 179	1 179	3	3	5	4
		gas	2 500	5 000	453	453	5	4	9	8
		electricity	2 500	5 000	864	864	3	3	6	6

TABLE B.9

SPACE HEATING
WINNIPEG - SINGLE-DETACHED

Option	Standards	Fuel	Installed Cost ($1981)		Savings in First Year ($1981)		Payback Period (years)			
			Owner	Contractor	Low Price Scenario	High Price Scenario	Owner		Contractor	
							Low Price Scenario	High Price Scenario	Low Price Scenario	High Price Scenario
ATTIC	Low to High	oil	600	600	279	279	2	2	2	2
		gas	600	600	132	132	3	3	4	4
		electricity	600	600	109	109	2	2	4	4
	Minimum to High	oil	350	525	131	131	4	4	5	4
		gas	350	525	60	60	5	4	8	7
		electricity	350	525	89	89	5	5	8	8
BASEMENT	Low to High	oil	450	900	541	541	1	1	2	2
		gas	450	900	256	256	2	2	3	3
		electricity	450	900	365	365	2	2	3	3
EXTERIOR WALLS	Low to High	oil	450	1 000	174	174	3	3	6	6
		gas	450	1 000	79	79	5	5	>10	10
		electricity	450	1 000	117	117	5	5	>10	>10
	Minimum to High	oil	400	900	50	50	7	7	>10	>10
		gas	400	900	23	23	>10	>10	>10	>10
		electricity	400	900	34	34	>10	>10	>10	>10
WINDOWS, DOORS AND WEATHERSTRIPPING	Low to High	oil	1 200	2 500	190	190	6	6	>10	>10
		gas	1 200	2 500	90	90	>10	>10	>10	>10
		electricity	1 200	2 500	120	120	>10	>10	>10	>10
TOTAL	Low to High	oil	2 500	5 000	1 184	1 184	3	3	6	6
		gas	2 500	5 000	557	557	4	4	9	9
		electricity	2 500	5 000	799	799	4	4	9	9

TABLE B.10

SPACE HEATING
TORONTO - SINGLE-DETACHED

Option	Standards	Fuel	Installed Cost ($1981)		Savings in First Year ($1981)		Payback Period (years)			
			Owner	Contractor	Low Price Scenario	High Price Scenario	Owner		Contractor	
							Low Price Scenario	High Price Scenario	Low Price Scenario	High Price Scenario
ATTIC	Low to High	oil	400	600	189	189	2	2	3	3
		gas	400	600	106	106	4	3	6	5
		electricity	400	600	161	161	3	3	4	4
	Minimum to High	oil	350	525	97	97	3	3	5	5
		gas	350	525	55	55	6	5	10	9
		electricity	350	525	82	82	4	4	7	7
BASEMENT	Low to High	oil	450	900	384	384	2	2	3	3
		gas	450	900	216	216	3	2	5	4
		electricity	450	900	326	326	2	2	3	3
EXTERIOR WALLS	Low to High	oil	450	1 000	93	93	5	5	>10	10
		gas	450	1 000	50	50	10	8	>10	>10
		electricity	450	1 000	79	79	7	7	>10	>10
	Minimum to High	oil	400	900	31	31	8	8	>10	>10
		gas	400	900	14	14	>10	>10	>10	>10
		electricity	400	900	27	27	>10	>10	>10	>10
WINDOWS, DOORS AND WEATHERSTRIPPING	Low to High	oil	1 200	2 500	137	137	9	8	>10	>10
		gas	1 200	2 500	73	73	>10	>10	>10	>10
		electricity	1 200	2 500	116	116	>10	>10	>10	>10
TOTAL	Low to High	oil	2 500	5 000	803	803	3	3	7	6
		gas	2 500	5 000	445	445	6	5	>10	>10
		electricity	2 500	5 000	682	682	4	4	8	8

TABLE B.11

SPACE HEATING
MONTREAL - SINGLE DETACHED

Option	Standards	Fuel	Installed Cost ($1981)		Savings in First Year ($1981)		Payback Period (years)			
			Owner	Contractor	Low Price Scenario	High Price Scenario	Owner		Contractor	
							Low Price Scenario	High Price Scenario	Low Price Scenario	High Price Scenario
ATTIC	Low to High	oil	400	600	205	205	2	2	3	3
		gas	400	600	128	128	3	3	4	4
		electricity	400	600	149	149	3	3	4	4
	Minimum to High	oil	300	525	104	104	3	3	5	5
		gas	300	525	62	62	5	4	8	7
		electricity	300	525	76	76	4	4	7	7
BASEMENT	Low to High	oil	450	900	415	415	2	2	3	3
		gas	450	900	257	257	2	2	4	4
		electricity	450	900	301	301	2	2	3	3
EXTERIOR WALLS	Low to High	oil	450	1 000	99	99	5	5	>10	9
		gas	450	1 000	62	62	7	7	>10	>10
		electricity	450	1 000	73	73	7	7	>10	>10
	Minimum to High	oil	400	900	34	34	>10	10	>10	>10
		gas	400	900	21	21	>10	>10	>10	>10
		electricity	400	900	25	25	>10	>10	>10	>10
WINDOWS, DOORS AND WEATHERSTRIPPING	Low to High	oil	1 200	2 500	147	147	9	8	>10	>10
		gas	1 200	2 500	92	92	>10	>10	>10	>10
		electricity	1 200	2 500	107	107	>10	>10	>10	>10
TOTAL	Low to High	oil	2 500	5 000	866	866	3	3	6	6
		gas	2 500	5 000	539	539	5	5	10	9
		electricity	2 500	5 000	630	630	4	4	9	8

TABLE B.12

SPACE HEATING
SAINT JOHN - SINGLE-DETACHED

Option	Standards	Fuel	Installed Cost ($1981)		Savings in First Year ($1981)		Payback Period (years)			
							Owner		Contractor	
			Owner	Contractor	Low Price Scenario	High Price Scenario	Low Price Scenario	High Price Scenario	Low Price Scenario	High Price Scenario
ATTIC	Low to High	oil	400	600	222	222	2	2	3	3
		electricity	400	600	205	205	2	2	3	3
	Minimum to High	oil	350	525	113	113	3	3	5	4
		electricity	350	525	105	105	4	4	6	6
BASEMENT	Low to High	oil	450	900	448	448	1	1	2	2
		electricity	450	900	418	418	2	2	3	3
EXTERIOR WALLS	Low to High	oil	450	1 000	109	109	5	4	10	9
		electricity	450	1 000	100	100	6	6	>10	>10
	Minimum to High	oil	400	900	37	37	10	9	>10	>10
		electricity	400	900	34	34	>10	>10	>10	>10
WINDOWS, DOORS AND WEATHERSTRIPPING	Low to High	oil	1 200	2 500	159	159	8	7	>10	>10
		electricity	1 200	2 500	147	147	>10	>10	>10	>10
TOTAL	Low to High	oil	2 500	5 000	938	938	3	3	6	5
		electricity	2 500	5 000	870	870	4	4	7	7

TABLE 8.13

SPACE HEATING
ST. JOHN'S SINGLE-DETACHED

Option	Standards	Fuel	Installed Cost ($1981)		Savings in First Year ($1981)		Payback Period (years)			
							Owner		Contractor	
			Owner	Contractor	Low Price Scenario	High Price Scenario	Low Price Scenario	High Price Scenario	Low Price Scenario	High Price Scenario
ATTIC	Low to High	oil	400	600	237	237	2	2	3	3
		electricity	400	600	193	193	2	2	3	3
	Minimum to High	oil	350	525	120	120	3	3	5	4
		electricity	350	525	99	99	4	4	6	6
BASEMENT	Low to High	oil	450	900	480	480	1	1	2	2
		electricity	450	900	390	390	2	2	3	3
EXTERIOR WALLS	Low to High	oil	450	1 000	115	115	4	4	10	9
		electricity	450	1 000	94	94	5	5	>10	>10
	Minimum to High	oil	400	900	39	39	10	9	>10	>10
		electricity	400	900	32	32	>10	>10	>10	>10
WINDOWS, DOORS AND WEATHERSTRIPPING	Low to High	oil	1 200	2 500	26	26	>10	>10	>10	>10
		electricity	1 200	2 500	22	22	>10	>10	>10	>10
TOTAL	Low to High	oil	2 500	5 000	858	858	3	3	7	6
		electricity	2 500	5 000	699	699	4	4	8	8

TABLE B.14

SPACE HEATING
HALIFAX - SINGLE-DETACHED

Option	Standards	Fuel	Installed Cost ($1981)		Savings in First Year ($1981)		Payback Period (years)			
			Owner	Contractor	Low Price Scenario	High Price Scenario	Owner		Contractor	
							Low Price Scenario	High Price Scenario	Low Price Scenario	High Price Scenario
ATTIC	Low to High	oil	400	600	190	190	2	2	3	3
		electricity	400	600	236	236	2	2	3	3
	Minimum to High	oil	350	525	97	97	3	3	6	5
		electricity	350	525	121	121	3	3	5	5
BASEMENT	Low to High	oil	450	900	384	384	2	2	3	3
		electricity	450	900	478	478	1	1	2	2
EXTERIOR WALLS	Low to High	oil	450	1 000	92	92	5	5	>10	10
		electricity	450	1 000	116	116	5	5	>10	>10
	Minimum to High	oil	400	900	31	31	>10	10	>10	>10
		electricity	400	900	39	39	>10	>10	>10	>10
WINDOWS, DOORS AND WEATHERSTRIPPING	Low to High	oil	1 200	2 500	21	21	>10	>10	>10	>10
		electricity	1 200	2 500	27	27	>10	>10	>10	>10
TOTAL	Low to High	oil	2 500	5 000	687	687	4	4	8	7
		electricity	2 500	5 000	857	857	4	4	8	8

TABLE B.15

SPACE HEATING
VICTORIA - SEMI-DETACHED

Option	Standards	Fuel	Installed Cost ($1981)		Savings in First Year ($1981)		Payback Period (years)			
							Owner		Contractor	
			Owner	Contractor	Low Price Scenario	High Price Scenario	Low Price Scenario	High Price Scenario	Low Price Scenario	High Price Scenario
ATTIC	Low to High	oil	200	300	78	98	3	2	5	4
		electricity	200	300	64	64	4	4	6	6
	Minimum to High	oil	175	275	47	59	4	3	7	5
		electricity	175	275	39	39	4	4	9	9
BASEMENT	Low to High	oil	250	500	171	216	2	2	3	3
		electricity	250	500	140	140	2	2	4	4
EXTERIOR WALLS	Low to High	oil	500	1 100	89	112	7	6	>10	>10
		electricity	500	1 100	72	72	9	9	>10	>10
	Minimum to High	oil	450	1 000	28	35	>10	>10	>10	>10
		electricity	450	1 000	23	23	>10	>10	>10	>10
WINDOWS, DOORS AND WEATHERSTRIPPING	Low to High	oil	1 000	2 200	113	143	10	7	>10	>10
		electricity	1 000	2 200	93	93	>10	>10	>10	>10
TOTAL	Low to High	oil	1 950	4 100	451	569	5	4	>10	8
		electricity	1 950	4 100	369	369	7	7	>10	>10

TABLE B.16

SPACE HEATING
VANCOUVER - SEMI-DETACHED

Option	Standards	Fuel	Installed Cost ($1981)		Savings in First Year ($1981)		Payback Period (years)			
							Owner		Contractor	
			Owner	Contractor	Low Price Scenario	High Price Scenario	Low Price Scenario	High Price Scenario	Low Price Scenario	High Price Scenario
ATTIC	Low to High	oil	200	300	77	97	3	2	5	4
		gas	200	300	31	31	6	5	10	9
		electricity	200	300	63	63	4	4	6	6
	Minimum to High	oil	175	275	46	57	4	3	7	5
		gas	175	275	17	17	8	7	10	>10
		electricity	175	275	38	38	4	4	6	9
BASEMENT	Low to High	oil	250	500	168	211	2	2	3	3
		gas	250	500	70	70	4	3	7	6
		electricity	250	500	137	137	2	2	4	4
EXTERIOR WALLS	Low to High	oil	500	1 100	87	109	7	7	>10	>10
		gas	500	1 100	35	35	>10	>10	>10	>10
		electricity	500	1 100	71	71	10	10	>10	>10
	Minimum to High	oil	450	1 000	27	34	>10	>10	>10	>10
		gas	450	1 000	10	10	>10	>10	>10	>10
		electricity	450	1 000	22	22	>10	>10	>10	>10
WINDOWS, DOORS AND WEATHERSTRIPPING	Low to High	oil	1 000	2 200	111	140	10	7	>10	>10
		gas	1 000	2 200	45	45	>10	>10	>10	>10
		electricity	1 000	2 200	91	91	>10	>10	>10	>10
TOTAL	Low to High	oil	1 950	4 100	443	557	5	4	>10	8
		gas	1 950	4 100	181	181	>10	10	>10	>10
		electricity	1 950	4 100	362	362	7	7	>10	>10

TABLE B.17

SPACE HEATING
CALGARY - SEMI-DETACHED

Option	Standards	Fuel	Installed Cost ($1981)		Savings in First Year ($1981)		Payback Period (years)			
			Owner	Contractor	Low Price Scenario	High Price Scenario	Owner		Contractor	
							Low Price Scenario	High Price Scenario	Low Price Scenario	High Price Scenario
ATTIC	Low to High	gas	200	300	50	50	4	3	6	5
	Minimum to High	gas	175	275	21	21	7	6	>10	10
BASEMENT	Low to High	gas	250	500	106	106	2	2	4	4
EXTERIOR WALLS	Low to High	gas	500	1 100	71	71	7	6	>10	>10
	Minimum to High	gas	450	1 000	18	18	>10	>10	>10	>10
WINDOWS, DOORS AND WEATHERSTRIPPING	Low to High	gas	1 000	2 200	71	71	>10	10	>10	>10
TOTAL	Low to High	gas	1 950	4 100	298	298	6	5	>10	>10

TABLE B.18

SPACE HEATING
EDMONTON - SEMI-DETACHED

Option	Standards	Fuel	Installed Cost ($1981)		Savings in First Year ($1981)		Payback Period (years)			
			Owner	Contractor	Low Price Scenario	High Price Scenario	Owner		Contractor	
							Low Price Scenario	High Price Scenario	Low Price Scenario	High Price Scenario
ATTIC	Low to High	gas	200	300	53	53	3	3	6	5
	Minimum to High	gas	175	275	24	24	5	5	10	9
BASEMENT	Low to High	gas	250	500	109	109	2	2	4	4
EXTERIOR WALLS	Low to High	gas	500	1 100	74	74	7	6	>10	>10
	Minimum to High	gas	450	1 000	21	21	>10	>10	>10	>10
WINDOWS, DOORS AND WEATHERSTRIPPING	Low to High	gas	1 000	2 200	74	74	>10	10	>10	>10
TOTAL	Low to High	gas	1 950	4 100	310	310	6	5	>10	10

TABLE B.19

SPACE HEATING
REGINA - SEMI-DETACHED

Option	Standards	Fuel	Installed Cost ($1981)		Savings in First Year ($1981)		Payback Period (years)			
			Owner	Contractor	Low Price Scenario	High Price Scenario	Owner		Contractor	
							Low Price Scenario	High Price Scenario	Low Price Scenario	High Price Scenario
ATTIC	Low to High	oil	200	300	153	153	2	2	3	3
		gas	200	300	58	58	3	3	5	5
		electricity	200	300	112	112	2	2	3	3
	Minimum to High	oil	175	275	66	66	3	3	5	5
		gas	175	275	24	24	5	5	10	9
		electricity	175	275	49	49	3	3	6	6
BASEMENT	Low to High	oil	250	500	315	315	1	1	2	2
		gas	250	500	122	122	2	2	4	4
		electricity	250	500	231	231	2	2	3	3
EXTERIOR WALLS	Low to High	oil	500	1 100	211	211	3	3	6	6
		gas	500	1 100	82	82	6	6	>10	10
		electricity	500	1 100	155	155	4	4	8	8
	Minimum to High	oil	450	1 000	58	58	9	9	>10	>10
		gas	450	1 000	21	21	>10	>10	>10	>10
		electricity	450	1 000	43	43	>10	>10	>10	>10
WINDOWS, DOORS AND WEATHERSTRIPPING	Low to High	oil	1 000	2 200	211	211	5	5	>10	10
		gas	1 000	2 200	82	82	10	9	>10	>10
		electricity	1 000	2 200	155	155	7	7	>10	>10
TOTAL	Low to High	oil	1 950	4 100	890	890	3	3	5	5
		gas	1 950	4 100	344	344	5	5	>10	9
		electricity	1 950	4 100	653	653	4	4	7	7

TABLE B.20

SPACE HEATING
WINNIPEG - SEMI-DETACHED

Option	Standards	Fuel	Installed Cost ($1981)		Savings in First Year ($1981)		Payback Period (years)			
							Owner		Contractor	
			Owner	Contractor	Low Price Scenario	High Price Scenario	Low Price Scenario	High Price Scenario	Low Price Scenario	High Price Scenario
ATTIC	Low to High	oil	200	300	154	154	2	2	3	3
		gas	200	300	71	71	3	3	5	4
		electricity	200	300	104	104	2	3	3	4
	Minimum to High	oil	150	275	67	67	3	3	5	4
		gas	150	275	30	30	5	4	9	8
		electricity	150	275	45	45	4	4	9	9
BASEMENT	Low to High	oil	250	500	317	317	1	1	2	2
		gas	250	500	147	147	2	2	3	3
		electricity	250	500	213	213	2	2	3	3
EXTERIOR WALLS	Low to High	oil	500	1 100	212	212	3	3	6	5
		gas	500	1 100	98	98	6	5	>10	10
		electricity	500	1 100	144	144	6	6	>10	>10
	Minimum to High	oil	450	1 000	58	58	9	8	>10	>10
		gas	450	1 000	26	26	>10	>10	>10	>10
		electricity	450	1 000	40	40	>10	>10	>10	>10
WINDOWS, DOORS AND WEATHERSTRIPPING	Low to High	oil	1 000	2 200	212	212	5	5	>10	10
		gas	1 000	2 200	98	98	10	8	>10	>10
		electricity	1 000	2 200	144	144	10	10	>10	>10
TOTAL	Low to High	oil	1 950	4 100	895	895	3	3	5	5
		gas	1 950	4 100	414	414	5	5	10	9
		electricity	1 950	4 100	605	605	5	5	>10	>10

TABLE 8.21

SPACE HEATING
TORONTO - SEMI-DETACHED

Option	Standards	Fuel	Installed Cost ($1981)		Savings in First Year ($1981)		Payback Period (years)			
							Owner		Contractor	
			Owner	Contractor	Low Price Scenario	High Price Scenario	Low Price Scenario	High Price Scenario	Low Price Scenario	High Price Scenario
ATTIC	Low to High	oil	200	300	99	99	2	2	4	4
		gas	200	300	55	55	4	4	7	6
		electricity	200	300	84	84	3	3	5	5
	Minimum to High	oil	150	275	49	49	3	3	6	6
		gas	150	275	28	28	5	5	>10	10
		electricity	150	275	42	42	4	4	8	8
BASEMENT	Low to High	oil	250	500	209	209	2	2	3	3
		gas	250	500	115	115	2	2	5	4
		electricity	250	500	178	178	2	2	3	3
EXTERIOR WALLS	Low to High	oil	500	1 100	138	138	5	4	9	8
		gas	500	1 100	78	78	8	7	>10	>10
		electricity	500	1 100	117	117	6	6	>10	>10
	Minimum to High	oil	450	1 000	34	34	>10	>10	>10	>10
		gas	450	1 000	18	18	>10	>10	>10	>10
		electricity	450	1 000	29	29	>10	>10	>10	>10
WINDOWS, DOORS AND WEATHERSTRIPPING	Low to High	oil	1 000	2 200	140	140	7	7	8	>10
		gas	1 000	2 200	78	78	>10	>10	>10	>10
		electricity	1 000	2 200	119	119	10	10	10	>10
TOTAL	Low to High	oil	1 950	4 100	586	586	4	4	4	7
		gas	1 950	4 100	326	326	7	7	7	>10
		electricity	1 950	4 100	498	498	5	5	5	>10

TABLE B.22

SPACE HEATING
MONTREAL - SEMI-DETACHED

Option	Standards	Fuel	Installed Cost ($1981)		Savings in First Year ($1981)		Payback Period (years)			
							Owner		Contractor	
			Owner	Contractor	Low Price Scenario	High Price Scenario	Low Price Scenario	High Price Scenario	Low Price Scenario	High Price Scenario
ATTIC	Low to High	oil	200	300	106	106	2	2	4	4
		gas	200	300	67	67	3	3	5	5
		electricity	200	300	78	78	3	3	5	4
	Minimum to High	oil	150	275	53	53	3	3	6	6
		gas	150	275	31	31	5	5	10	9
		electricity	150	275	39	39	4	4	9	8
BASEMENT	Low to High	oil	250	500	226	226	2	2	3	3
		gas	250	500	139	139	2	2	4	4
		electricity	250	500	165	165	2	2	3	3
EXTERIOR WALLS	Low to High	oil	500	1 100	149	149	4	4	9	8
		gas	500	1 100	92	92	7	6	>10	>10
		electricity	500	1 100	109	109	6	6	>10	>10
	Minimum to High	oil	450	1 000	36	36	>10	9	>10	>10
		gas	450	1 000	21	21	>10	>10	>10	>10
		electricity	450	1 000	26	26	>10	>10	>10	>10
WINDOWS, DOORS AND WEATHERSTRIPPING	Low to High	oil	1 000	2 200	151	151	7	6	>10	>10
		gas	1 000	2 200	92	92	>10	10	>10	>10
		electricity	1 000	2 200	110	110	10	10	>10	>10
TOTAL	Low to High	oil	1 950	4 100	632	632	4	4	8	7
		gas	1 950	4 100	390	390	6	5	>10	>10
		electricity	1 950	4 100	462	462	5	5	>10	>10

TABLE B.21

SPACE HEATING
TORONTO - SEMI-DETACHED

Option	Standards	Fuel	Installed Cost ($1981)		Savings in First Year ($1981)		Payback Period (years)			
			Owner	Contractor	Low Price Scenario	High Price Scenario	Owner		Contractor	
							Low Price Scenario	High Price Scenario	Low Price Scenario	High Price Scenario
ATTIC	Low to High	oil	200	300	99	99	2	2	4	4
		gas	200	300	55	55	4	4	7	6
		electricity	200	300	84	84	3	3	5	5
	Minimum to High	oil	150	275	49	49	3	3	6	6
		gas	150	275	28	28	5	5	>10	10
		electricity	150	275	42	42	4	4	8	8
BASEMENT	Low to High	oil	250	500	209	209	2	2	3	3
		gas	250	500	115	115	2	2	5	4
		electricity	250	500	178	178	2	2	3	3
EXTERIOR WALLS	Low to High	oil	500	1 100	138	138	5	4	9	8
		gas	500	1 100	78	78	8	7	>10	>10
		electricity	500	1 100	117	117	6	6	>10	>10
	Minimum to High	oil	450	1 000	34	34	>10	>10	>10	>10
		gas	450	1 000	18	18	>10	>10	>10	>10
		electricity	450	1 000	29	29	>10	>10	>10	>10
WINDOWS, DOORS AND WEATHERSTRIPPING	Low to High	oil	1 000	2 200	140	140	7	7	8	>10
		gas	1 000	2 200	78	78	>10	>10	>10	>10
		electricity	1 000	2 200	119	119	10	10	10	>10
TOTAL	Low to High	oil	1 950	4 100	586	586	4	4	4	7
		gas	1 950	4 100	326	326	7	7	7	>10
		electricity	1 950	4 100	498	498	5	5	5	>10

TABLE B.22

SPACE HEATING
MONTREAL - SEMI-DETACHED

Option	Standards	Fuel	Installed Cost ($1981)		Savings in First Year ($1981)		Payback Period (years)			
							Owner		Contractor	
			Owner	Contractor	Low Price Scenario	High Price Scenario	Low Price Scenario	High Price Scenario	Low Price Scenario	High Price Scenario
ATTIC	Low to High	oil	200	300	106	106	2	2	4	4
		gas	200	300	67	67	3	3	5	5
		electricity	200	300	78	78	3	3	5	4
	Minimum to High	oil	150	275	53	53	3	3	6	6
		gas	153	275	31	31	5	5	10	9
		electricity	150	275	39	39	4	4	9	8
BASEMENT	Low to High	oil	250	500	226	226	2	2	3	3
		gas	250	500	139	139	2	2	4	4
		electricity	250	500	165	165	2	2	3	3
EXTERIOR WALLS	Low to High	oil	500	1 100	149	149	4	4	9	8
		gas	500	1 100	92	92	7	6	>10	>10
		electricity	500	1 100	109	109	6	6	>10	>10
	Minimum to High	oil	450	1 000	36	36	>10	9	>10	>10
		gas	450	1 000	21	21	>10	>10	>10	>10
		electricity	450	1 000	26	26	>10	>10	>10	>10
WINDOWS, DOORS AND WEATHERSTRIPPING	Low to High	oil	1 000	2 200	151	151	7	6	>10	>10
		gas	1 000	2 200	92	92	>10	10	>10	>10
		electricity	1 000	2 200	110	110	10	10	>10	>10
TOTAL	Low to High	oil	1 950	4 100	632	632	4	4	8	7
		gas	1 950	4 100	390	390	6	5	>10	>10
		electricity	1 950	4 100	462	462	5	5	>10	>10

TABLE B.23

SPACE HEATING
SAINT JOHN - SEMI-DETACHED

Option	Standards	Fuel	Installed Cost ($1981)		Savings in First Year ($1981)		Payback Period (years)			
							Owner		Contractor	
			Owner	Contractor	Low Price Scenario	High Price Scenario	Low Price Scenario	High Price Scenario	Low Price Scenario	High Price Scenario
ATTIC	Low to High	oil	200	300	115	115	2	2	3	3
		electricity	200	300	107	107	2	2	4	4
	Minimum to High	oil	175	275	57	57	3	3	6	5
		electricity	175	275	53	53	4	4	7	7
BASEMENT	Low to High	oil	250	500	245	245	2	2	2	2
		electricity	250	500	226	226	2	2	3	3
EXTERIOR WALLS	Low to High	oil	500	1 100	161	161	4	4	8	7
		electricity	500	1 100	150	150	5	5	>10	>10
	Minimum to High	oil	450	1 000	39	39	>10	>10	>10	>10
		electricity	450	1 000	36	36	>10	>10	>10	>10
WINDOWS, DOORS AND WEATHERSTRIPPING	Low to High	oil	1 000	2 200	164	164	7	6	>10	>10
		electricity	1 000	2 200	152	152	9	9	>10	>10
TOTAL	Low to High	oil	1 950	4 100	685	685	4	3	8	6
		electricity	1 950	4 100	635	635	5	5	10	10

TABLE B.24

SPACE HEATING
ST. JOHN'S - SEMI-DETACHED

Option	Standards	Fuel	Installed Cost ($1981)		Savings in First Year ($1981)		Payback Period (years)			
							Owner		Contractor	
			Owner	Contractor	Low Price Scenario	High Price Scenario	Low Price Scenario	High Price Scenario	Low Price Scenario	High Price Scenario
ATTIC	Low to High	oil	200	300	174	174	2	2	3	3
		electricity	200	300	101	101	2	2	4	4
	Minimum to High	oil	150	275	62	62	3	3	5	5
		electricity	150	275	50	50	3	3	7	7
BASEMENT	Low to High	oil	250	500	262	262	1	1	2	2
		electricity	250	500	213	213	2	2	3	3
EXTERIOR WALLS	Low to High	oil	500	1 100	173	173	4	3	8	7
		electricity	500	1 100	141	141	5	5	>10	10
	Minimum to High	oil	450	1 000	42	42	>10	>10	>10	>10
		electricity	450	1 000	34	34	>10	>10	>10	>10
WINDOWS, DOORS AND WEATHERSTRIPPING	Low to High	oil	1 000	2 200	26	26	>10	>10	>10	>10
		electricity	1 000	2 200	22	22	2	>10	5	>10
TOTAL	Low to High	oil	1 950	4 100	585	585	4	3	9	5
		electricity	1 950	4 100	477	477	5	5	10	>10

TABLE B.25

SPACE HEATING
HALIFAX - SEMI-DETACHED

Option	Standards	Fuel	Installed Cost ($1981)		Savings in First Year ($1981)		Payback Period (years)			
							Owner		Contractor	
			Owner	Contractor	Low Price Scenario	High Price Scenario	Low Price Scenario	High Price Scenario	Low Price Scenario	High Price Scenario
ATTIC	Low to High	oil	200	300	99	99	2	2	4	4
		electricity	200	300	123	123	2	2	4	4
	Minimum to High	oil	175	275	49	49	3	1	6	6
		electricity	175	275	62	62	3	3	6	6
BASEMENT	Low to High	oil	250	500	210	210	2	2	2	3
		electricity	250	500	261	261	1	1	1	3
EXTERIOR WALLS	Low to High	oil	500	1 100	139	139	5	4	9	8
		electricity	500	1 100	172	172	4	4	9	9
	Minimum to High	oil	450	1 000	33	33	>10	>10	>10	>10
		electricity	450	1 000	42	42	>10	>10	>10	>10
WINDOWS, DOORS AND WEATHERSTRIPPING	Low to High	oil	1 000	2 200	21	21	>10	>10	>10	>10
		electricity	1 000	2 200	27	27	>10	>10	>10	>10
TOTAL	Low to High	oil	1 950	4 100	469	469	>10	5	5	9
		electricity	1 950	4 100	583	583	>10	5	5	>10

TABLE B.26

SPACE HEATING
VICTORIA - ROWHOUSE

Option	Standards	Fuel	Installed Cost ($1981)		Savings in First Year ($1981)		Payback Period (years)			
							Owner		Contractor	
			Owner	Contractor	Low Price Scenario	High Price Scenario	Low Price Scenario	High Price Scenario	Low Price Scenario	High Price Scenario
ATTIC	Low to High	oil	200	300	69	87	3	3	5	4
		electricity	200	300	57	57	4	4	6	6
	Minimum to High	oil	175	275	44	56	4	3	7	5
		electricity	175	275	36	36	5	5	8	8
BASEMENT	Low to High	oil	200	400	53	67	4	3	8	6
		electricity	200	400	43	43	5	5	10	10
EXTERIOR WALLS	Low to High	oil	300	650	44	56	7	6	>10	>10
		electricity	300	650	36	36	9	9	>10	>10
	Minimum to High	oil	275	600	18	22	>10	9	>10	>10
		electricity	275	600	14	14	>10	>10	>10	>10
WINDOWS, DOORS AND WEATHERSTRIPPING	Low to High	oil	900	2 000	90	113	10	8	>10	>10
		electricity	900	2 000	74	74	>10	>10	>10	>10
TOTAL	Low to High	oil	1 600	3 350	256	323	6	4	>10	9
		electricity	1 600	3 350	210	210	7	7	>10	>10

TABLE B.27

SPACE HEATING
VANCOUVER - ROWHOUSE

Option	Standards	Fuel	Installed Cost ($1981)		Savings in First Year ($1981)		Payback Period (years)			
							Owner		Contractor	
			Owner	Contractor	Low Price Scenario	High Price Scenario	Low Price Scenario	High Price Scenario	Low Price Scenario	High Price Scenario
ATTIC	Low to High	oil	200	300	68	85	3	3	5	4
		gas	200	300	28	28	7	6	10	9
		electricity	200	300	55	55	4	4	6	6
	Minimum to High	oil	175	275	43	55	4	4	7	5
		gas	175	275	17	17	9	8	>10	>10
		electricity	175	275	35	35	6	6	8	8
BASEMENT	Low to High	oil	200	400	51	64	4	3	8	6
		gas	200	400	21	21	9	8	>10	>10
		electricity	200	400	42	42	5	5	>10	>10
EXTERIOR WALLS	Low to High	oil	300	650	43	55	7	6	>10	>10
		gas	300	650	17	17	>10	>10	>10	>10
		electricity	300	650	35	35	10	10	>10	>10
	Minimum to High	oil	275	600	17	21	>10	10	>10	>10
		gas	275	600	7	7	>10	>10	>10	>10
		electricity	275	600	14	14	>10	>10	>10	>10
WINDOWS, DOORS AND WEATHERSTRIPPING	Low to High	oil	900	2 000	88	111	>10	8	>10	>10
		gas	900	2 000	38	38	>10	>10	>10	>10
		electricity	900	2 000	72	72	>10	>10	>10	>10
TOTAL	Low to High	oil	1 600	3 350	250	315	6	5	>10	9
		gas	1 600	3 350	104	104	>10	10	>10	>10
		electricity	1 600	3 350	204	204	7	7	>10	>10

TABLE B.28

SPACE HEATING
CALGARY - ROWHOUSE

Option	Standards	Fuel	Installed Cost ($1981)		Savings in First Year ($1981)		Payback Period (years)			
			Owner	Contractor	Low Price Scenario	High Price Scenario	Owner		Contractor	
							Low Price Scenario	High Price Scenario	Low Price Scenario	High Price Scenario
ATTIC	Low to High	gas	200	300	47	47	4	4	5	5
	Minimum to High	gas	175	275	21	21	7	6	>10	>10
BASEMENT	Low to High	gas	200	400	71	71	4	4	6	5
EXTERIOR WALLS	Low to High	gas	300	650	47	47	8	7	>10	>10
	Minimum to High	gas	275	600	12	12	>10	>10	>10	>10
WINDOWS, DOORS AND WEATHERSTRIPPING	Low to High	gas	900	2 000	56	56	>10	>10	>10	>10
TOTAL	Low to High	gas	1 600	3 350	221	221	6	5	>10	10

TABLE B.29

SPACE HEATING
EDMONTON - ROWHOUSE

Option	Standards	Fuel	Installed Cost ($1981)		Savings in First Year ($1981)		Payback Period (years)			
							Owner		Contractor	
			Owner	Contractor	Low Price Scenario	High Price Scenario	Low Price Scenario	High Price Scenario	Low Price Scenario	High Price Scenario
ATTIC	Low to High	gas	200	300	47	47	4	4	5	5
	Minimum to High	gas	175	275	21	21	7	6	>10	>10
BASEMENT	Low to High	gas	200	400	74	74	4	4	6	5
EXTERIOR WALLS	Low to High	gas	300	[illegible]3	50	50	5	5	>10	10
	Minimum to High	gas	275	600	12	12	>10	>10	>10	>10
WINDOWS, DOORS AND WEATHERSTRIPPING	Low to High	gas	900	2 000	59	59	>10	>10	>10	>10
TOTAL	Low to High	gas	1 600	3 350	230	230	6	5	>10	10

TABLE B.30

SPACE HEATING
REGINA - ROWHOUSE

Option	Standards	Fuel	Installed Cost ($1981)		Savings in First Year ($1981)		Payback Period (years)			
			Owner	Contractor	Low Price Scenario	High Price Scenario	Owner		Contractor	
							Low Price Scenario	High Price Scenario	Low Price Scenario	High Price Scenario
ATTIC	Low to High	oil	200	300	140	140	2	2	3	3
		gas	200	300	52	52	3	3	5	5
		electricity	200	300	102	102	2	2	3	3
	Minimum to High	oil	175	275	63	63	3	3	5	4
		gas	175	275	24	24	6	5	9	8
		electricity	175	275	47	47	4	4	6	6
BASEMENT	Low to High	oil	200	400	211	211	2	2	3	3
		gas	200	400	82	82	3	3	5	5
		electricity	200	400	155	155	2	2	3	4
EXTERIOR WALLS	Low to High	oil	300	650	142	142	3	3	4	4
		gas	300	650	55	55	5	4	8	7
		electricity	300	650	104	104	3	3	5	5
	Minimum to High	oil	275	600	36	36	6	5	>10	>10
		gas	275	600	12	12	>10	>10	>10	>10
		electricity	275	600	27	27	8	8	>10	>10
WINDOWS, DOORS AND WEATHERSTRIPPING	Low to High	oil	900	2 000	167	167	6	5	>10	>10
		gas	900	2 000	64	64	>10	10	>10	>10
		electricity	900	2 000	122	122	8	8	>10	>10
TOTAL	Low to High	oil	1 600	3 350	660	660	3	3	5	5
		gas	1 600	3 350	253	253	5	5	10	8
		electricity	1 600	3 350	483	483	4	4	7	6

TABLE D.31

SPACE HEATING
WINNIPEG - ROWHOUSE

Option	Standards	Fuel	Installed Cost ($1981)		Savings in First Year ($1981)		Payback Period (years)			
							Owner		Contractor	
			Owner	Contractor	Low Price Scenario	High Price Scenario	Low Price Scenario	High Price Scenario	Low Price Scenario	High Price Scenario
ATTIC	Low to High	oil	200	300	140	140	2	2	3	3
		gas	200	300	64	64	3	3	4	4
		electricity	200	300	94	94	3	2	4	3
	Minimum to High	oil	175	275	64	64	3	3	4	4
		gas	175	275	30	30	5	5	8	8
		electricity	175	275	43	43	5	5	9	9
BASEMENT	Low to High	oil	200	400	212	212	2	2	3	3
		gas	200	400	98	98	3	3	5	5
		electricity	200	400	144	144	3	3	5	5
EXTERIOR WALLS	Low to High	oil	300	650	143	143	3	2	4	4
		gas	300	650	68	68	4	4	7	6
		electricity	300	650	96	96	4	4	7	7
	Minimum to High	oil	275	600	36	36	6	5	>10	>10
		gas	275	600	15	15	>10	>10	>10	>10
		electricity	275	600	25	25	>10	>10	>10	>10
WINDOWS, DOORS AND WEATHERSTRIPPING	Low to High	oil	900	2 000	167	167	6	5	>10	>10
		gas	900	2 000	79	79	>10	9	>10	>10
		electricity	900	2 000	113	113	>10	>10	>10	>10
TOTAL	Low to High	oil	1 600	3 350	662	662	3	3	5	5
		gas	1 600	3 350	309	309	5	5	9	8
		electricity	1 600	3 350	447	447	5	5	10	10

TABLE B.32

SPACE HEATING
TORONTO - ROWHOUSE

Option	Standards	Fuel	Installed Cost ($1981)		Savings in First Year ($1981)		Payback Period (years)			
			Owner	Contractor	Low Price Scenario	High Price Scenario	Owner		Contractor	
							Low Price Scenario	High Price Scenario	Low Price Scenario	High Price Scenario
ATTIC	Low to High	oil	200	300	93	93	3	2	4	3
		gas	200	300	50	50	4	2	4	3
		electricity	200	300	79	79	3	3	4	4
	Minimum to High	oil	175	275	47	47	4	4	6	6
		gas	175	275	23	23	8	8	>10	>10
		electricity	175	275	40	40	5	5	8	8
BASEMENT	Low to High	oil	200	400	150	150	2	2	4	4
		gas	200	400	83	83	4	4	6	6
		electricity	200	400	128	128	3	3	5	5
EXTERIOR WALLS	Low to High	oil	300	650	85	85	4	4	6	6
		gas	300	650	46	46	7	6	>10	10
		electricity	300	650	72	72	5	5	8	8
	Minimum to High	oil	275	600	24	24	9	8	10	>10
		gas	275	600	9	9	>10	>10	>10	>10
		electricity	275	600	20	20	>10	>10	>10	>10
WINDOWS, DOORS AND WEATHERSTRIPPING	Low to High	oil	900	2 000	120	120	8	7	>10	>10
		gas	900	2 000	64	64	>10	>10	>10	>10
		electricity	900	2 000	102	102	10	10	>10	>10
TOTAL	Low to High	oil	1 600	3 350	448	448	4	4	7	6
		gas	1 600	3 350	243	243	7	6	>10	>10
		electricity	1 600	3 350	381	381	5	5	9	9

TABLE H.33

SPACE HEATING
MONTREAL - ROWHOUSE

Option	Standards	Fuel	Installed Cost ($1981)		Savings in First Year ($1981)		Payback Period (years)			
			Owner	Contractor	Low Price Scenario	High Price Scenario	Owner		Contractor	
							Low Price Scenario	High Price Scenario	Low Price Scenario	High Price Scenario
ATTIC	Low to High	oil	200	300	99	99	2	2	3	3
		gas	200	300	62	62	3	3	5	5
		electricity	200	300	73	73	3	3	4	4
	Minimum to High	oil	175	275	51	51	4	4	6	5
		gas	175	275	31	31	6	5	8	8
		electricity	175	275	37	37	5	5	8	8
BASEMENT	Low to High	oil	200	400	162	162	2	2	3	3
		gas	200	400	97	97	3	3	5	5
		electricity	200	400	118	118	3	3	5	5
EXTERIOR WALLS	Low to High	oil	300	650	92	92	4	4	6	5
		gas	300	650	56	56	5	5	9	8
		electricity	300	650	67	67	5	5	8	8
	Minimum to High	oil	275	600	23	23	8	>10	>10	>10
		gas	275	600	15	15	>10	>10	>10	>10
		electricity	275	600	19	19	>10	>10	>10	>10
WINDOWS, DOORS AND WEATHERSTRIPPING	Low to High	oil	900	2 000	130	130	7	7	>10	>10
		gas	900	2 000	82	82	>10	10	>10	>10
		electricity	900	2 000	95	95	9	9	>10	>10
TOTAL	Low to High	oil	1 600	3 350	483	483	4	3	7	6
		gas	1 600	3 350	297	297	5	5	10	9
		electricity	1 600	3 350	353	353	5	5	9	9

TABLE B.34

SPACE HEATING
SAINT JOHN - ROWHOUSE

Option	Standards	Fuel	Installed Cost ($1981)		Savings in First Year ($1981)		Payback Period (years)			
			Owner	Contractor	Low Price Scenario	High Price Scenario	Owner		Contractor	
							Low Price Scenario	High Price Scenario	Low Price Scenario	High Price Scenario
ATTIC	Low to High	oil	200	300	109	109	2	2	3	3
		electricity	200	300	100	100	3	3	4	4
	Minimum to High	oil	175	275	55	55	3	3	5	5
		electricity	175	275	51	51	4	4	7	7
BASEMENT	Low to High	oil	200	400	176	176	2	2	3	3
		electricity	200	400	162	162	3	3	4	4
EXTERIOR WALLS	Low to High	oil	300	650	99	99	3	3	5	5
		electricity	300	650	92	92	4	4	7	7
	Minimum to High	oil	275	600	27	27	8	7	>10	>10
		electricity	275	600	26	26	10	10	>10	>10
WINDOWS, DOORS AND WEATHERSTRIPPING	Low to High	oil	900	2 000	141	141	7	6	>10	>10
		electricity	900	2 000	130	130	9	9	>10	>10
TOTAL	Low to High	oil	1 600	3 350	525	525	3	3	6	6
		electricity	1 600	3 350	484	484	4	4	8	8

TABLE 8.35

SPACE HEATING
ST. JOHN'S - ROWHOUSE

Option	Standards	Fuel	Installed Cost ($1981)		Savings in First Year ($1981)		Payback Period (years)			
			Owner	Contractor	Low Price Scenario	High Price Scenario	Owner		Contractor	
							Low Price Scenario	High Price Scenario	Low Price Scenario	High Price Scenario
ATTIC	Low to High	oil	200	300	115	115	2	2	3	3
		electricity	200	300	94	94	3	3	4	4
	Minimum to High	oil	175	275	58	58	3	3	5	5
		electricity	175	275	48	48	4	4	6	6
BASEMENT	Low to High	oil	200	400	188	188	2	2	3	3
		electricity	200	400	153	153	2	2	4	4
EXTERIOR WALLS	Low to High	oil	300	650	104	104	3	3	5	5
		electricity	300	650	86	86	4	4	7	7
	Minimum to High	oil	275	600	29	29	8	7	>10	>10
		electricity	275	600	24	24	9	9	>10	>10
WINDOWS, DOORS AND WEATHERSTRIPPING	Low to High	oil	900	2 000	29	29	>10	>10	>10	>10
		electricity	900	2 000	24	24	>10	>10	>10	>10
TOTAL	Low to High	oil	1 600	3 350	438	438	4	4	7	7
		electricity	1 600	3 350	367	367	5	5	9	9

TABLE B.36

SPACE HEATING
HALIFAX - ROWHOUSE

Option	Standards	Fuel	Installed Cost ($1981)		Savings in First Year ($1981)		Payback Period (years)			
			Owner	Contractor	Low Price Scenario	High Price Scenario	Owner		Contractor	
							Low Price Scenario	High Price Scenario	Low Price Scenario	High Price Scenario
ATTIC	Low to High	oil	200	300	92	92	3	2	4	3
		electricity	200	300	116	116	2	2	3	3
	Minimum to High	oil	175	275	67	67	4	4	6	6
		electricity	175	275	59	59	4	4	6	6
BASEMENT	Low to High	oil	200	400	150	150	2	2	4	4
		electricity	200	400	187	187	2	2	3	3
EXTERIOR WALLS	Low to High	oil	300	650	84	84	4	4	6	6
		electricity	300	650	106	106	4	4	6	6
	Minimum to High	oil	275	600	23	23	9	8	>10	>10
		electricity	275	600	30	30	9	9	>10	>10
WINDOWS, DOORS AND WEATHERSTRIPPING	Low to High	oil	900	200	23	23	>10	>10	>10	>10
		electricity	900	200	30	30	>10	>10	>10	>10
TOTAL	Low to High	oil	1 600	3 350	349	349	5	4	9	8
		electricity	1 600	3 350	439	439	4	4	9	9

TABLE B.37

ENERGY SAVINGS FROM THERMOSTAT SETBACK
VICTORIA - SINGLE-DETACHED

Option	Fuel	Capital Cost ($1981)	Savings in First Year ($1981)			Payback Period (years)		
			Low	Minimum	High	Low	Minimum	High
Manual thermostat setback	oil	0	88	58	36	.....	Immediate	.....
	electricity		78	48	32	.....	Immediate	.....
Automatic thermostat setback (owner installed)	oil	90	88	58	36	2	2	3
	electricity		78	48	32	2	2	3
Automatic thermostat (contractor installed)	oil	130	88	58	36	2	3	4
	electricity		78	48	32	2	3	5

TABLE 8.38

ENERGY SAVINGS FROM THERMOSTAT SETBACK
VANCOUVER - SINGLE-DETACHED

Option	Fuel	Capital Cost ($1981)	Savings in First Year ($1981)			Payback Period (years)		
			Low	Minimum	High	Low	Minimum	High
Manual thermostat setback	oil	0	85	57	36	.....	Immediate	.....
	gas		38	24	14	.....	Immediate	.....
	electricity		76	47	31	.....	Immediate	.....
Automatic thermostat setback (owner installed)	oil	90	85	57	36	2	2	3
	gas		38	24	14	3	4	6
	electricity		76	47	31	2	2	3
Automatic thermostat (contractor installed)	oil	130	85	57	36	2	3	4
	gas		38	24	14	3	5	9
	electricity		76	47	31	2	3	5

TABLE B.39

ENERGY SAVINGS FROM THERMOSTAT SETBACK
CALGARY - SINGLE-DETACHED

Option	Fuel	Capital Cost ($1981)	Savings in First Year ($1981)			Payback Period (years)		
			Low	Minimum	High	Low	Minimum	High
Manual thermostat setback	gas	0	56	30	21	..... Immediate		
Automatic thermostat setback (owner installed)	gas	90	56	30	21	2	3	4
Automatic thermostat (contractor installed)	gas	130	56	30	21	2	4	5

TABLE B.40

ENERGY SAVINGS FROM THERMOSTAT SETBACK
EDMONTON - SINGLE-DETACHED

Option	Fuel	Capital Cost ($1981)	Savings in First Year ($1981)			Payback Period (years)		
			Low	Minimum	High	Low	Minimum	High
Manual thermostat setback	gas	0	59	32	24	..... Immediate		
Automatic thermostat setback (owner installed)	gas	90	59	32	24	2	3	4
Automatic thermostat (contractor installed)	gas	130	59	32	24	2	4	5

TABLE B.41

ENERGY SAVINGS FROM THERMOSTAT SETBACK
REGINA - SINGLE-DETACHED

Option	Fuel	Capital Cost ($1981)	Savings in First Year ($1981)			Payback Period (years)		
			Low	Minimum	High	Low	Minimum	High
Manual thermostat setback	oil	0	166	89	62	.....	Immediate	.....
	gas		64	33	24	.....	Immediate	.....
	electricity		131	68	50	.....	Immediate	.....
Automatic thermostat setback (owner installed)	oil	90	166	89	62	1	2	2
	gas		64	33	24	2	3	3
	electricity		131	68	50	1	3	2
Automatic thermostat (contractor installed)	oil	130	166	89	62	1	2	3
	gas		64	33	24	2	4	5
	electricity		131	68	50	1	2	3

TABLE B.42

ENERGY SAVINGS FROM THERMOSTAT SETBACK
WINNIPEG - SINGLE-DETACHED

Option	Fuel	Capital Cost ($1981)	Savings in First Year ($1981)			Payback Period (years)		
			Low	Minimum	High	Low	Minimum	High
Manual thermostat setback	oil	0	166	89	63	.....	Immediate	.....
	gas		79	41	30	.....	Immediate	.....
	electricity		121	63	46	.....	Immediate	.....
Automatic thermostat setback (owner installed)	oil	90	166	89	63	1	2	2
	gas		79	41	30	2	2	3
	electricity		121	63	46	1	2	3
Automatic thermostat (contractor installed)	oil	130	166	89	63	1	2	3
	gas		79	41	30	2	3	4
	electricity		121	63	46	2	3	4

TABLE B.43

ENERGY SAVINGS FROM THERMOSTAT SETBACK
TORONTO - SINGLE-DETACHED

Option	Fuel	Capital Cost ($1981)	Savings in First Year ($1981)			Payback Period (years)		
			Low	Minimum	High	Low	Minimum	High
Manual thermostat setback	oil	0	118	65	46	.....	Immediate	.....
	gas		69	38	28	.....	Immediate	.....
	electricity		108	57	42	.....	Immediate	.....
Automatic thermostat setback (owner installed)	oil	90	118	65	46	1	2	2
	gas		69	38	28	2	3	4
	electricity		108	57	42	1	2	3
Automatic thermostat (contractor installed)	oil	130	118	65	46	2	2	3
	gas		69	38	28	2	4	5
	electricity		108	57	42	2	3	4

TABLE B.44

ENERGY SAVINGS FROM THERMOSTAT SETBACK
MONTREAL - SINGLE-DETACHED

Option	Fuel	Capital Cost ($1981)	Savings in First Year ($1981)			Payback Period (years)		
			Low	Minimum	High	Low	Minimum	High
Manual thermostat setback	oil	0	127	70	50	.....	Immediate	.....
	gas		82	46	31	.....	Immediate	.....
	electricity		100	53	39	.....	Immediate	.....
Automatic thermostat setback (owner installed)	oil	90	127	70	50	1	2	2
	gas		82	46	31	2	2	3
	electricity		100	53	39	1	2	3
Automatic thermostat (contractor installed)	oil	130	127	70	50	2	2	3
	gas		82	46	31	2	3	4
	electricity		100	53	39	2	3	4

TABLE B.45

ENERGY SAVINGS FROM THERMOSTAT SETBACK
SAINT JOHN - SINGLE-DETACHED

Option	Fuel	Capital Cost ($1981)	Savings in First Year ($1981)			Payback Period (years)		
			Low	Minimum	High	Low	Minimum	High
Manual thermostat setback	oil	0	137	76	54	.....	Immediate	.....
	electricity		137	63	54	.....	Immediate	.....
Automatic thermostat setback (owner installed)	oil	90	137	76	54	1	2	2
	electricity		137	73	54	1	2	2
Automatic thermostat (contractor installed)	oil	130	137	76	54	1	2	3
	electricity		137	73	54	1	2	3

TABLE B.46

ENERGY SAVINGS FROM THERMOSTAT SETBACK
ST. JOHN'S - SINGLE-DETACHED

Option	Fuel	Capital Cost ($1981)	Savings in First Year ($1981)			Payback Period (years)		
			Low	Minimum	High	Low	Minimum	High
Manual thermostat setback	oil	0	146	92	57	.....	Immediate	.....
	electricity		129	78	51	.....	Immediate	.....
Automatic thermostat setback (owner installed)	oil	90	146	92	57	1	1	2
	electricity		129	78	51	1	2	2
Automatic thermostat (contractor installed)	oil	130	146	92	57	1	2	3
	electricity		129	78	51	2	2	3

TABLE B.47

ENERGY SAVINGS FROM THERMOSTAT SETBACK
MILFORD - SINGLE-DETACHED

Option	Fuel	Capital Cost ($1981)	Savings in First Year ($1981)			Payback Period (years)		
			Low	Minimum	High	Low	Minimum	High
Manual thermostat setback	oil electricity	[illegible]	[illegible] [illegible]	[illegible] [illegible]	[illegible] [illegible]	[illegible] [illegible]	immediate immediate	[illegible] [illegible]
Automatic thermostat setback (owner installed)	oil electricity	[illegible]	[illegible] [illegible]	[illegible] [illegible]	[illegible] [illegible]	[illegible] [illegible]	[illegible] [illegible]	[illegible] [illegible]
Automatic thermostat (contractor installed)	oil electricity	[illegible]	[illegible] [illegible]	[illegible] [illegible]	[illegible] [illegible]	[illegible] [illegible]	[illegible] [illegible]	[illegible] [illegible]

TABLE 6.46

ENERGY SAVINGS FROM THERMOSTAT SETBACK
VICTORIA - SEMI-DETACHED

Option	Fuel	Capital Cost ($,'88)	Savings in First Year ($,'88)			Payback Period (years)		
			Low	Minimum	High	Low	Minimum	High
Manual thermostat setback	oil	[illegible]	[illegible]	[illegible]	[illegible]	.....	Immediate	.....
	electricity		[illegible]	[illegible]	[illegible]	.....	Immediate	.....
Automatic thermostat setback (owner installed)	oil	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	electricity		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	4
Automatic thermostat (contractor installed)	oil	130	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	4
	electricity		[illegible]	[illegible]	[illegible]	[illegible]	4	6

TABLE B.49

ENERGY SAVINGS FROM THERMOSTAT SETBACK
VANCOUVER - SEMI-DETACHED

Option	Fuel	Capital Cost ($1981)	Savings in First Year ($1981)			Payback Period (years)		
			Low	Minimum	High	Low	Minimum	High
Manual thermostat setback	oil	0	70	49	32	.....	Immediate	.....
	gas		31	21	14	.....	Immediate	.....
	electricity		61	41	28	.....	Immediate	.....
Automatic thermostat setback (owner installed)	oil	90	70	49	32	2	2	3
	gas		31	21	14	3	4	6
	electricity		61	41	28	2	3	4
Automatic thermostat (contractor installed)	oil	130	70	49	32	2	3	4
	gas		31	21	14	4	6	9
	electricity		61	41	28	3	4	5

TABLE B.50

ENERGY SAVINGS FROM THERMOSTAT SETBACK
CALGARY - SEMI-DETACHED

Option	Fuel	Capital Cost ($1981)	Savings in First Year ($1981)			Payback Period (years)		
			Low	Minimum	High	Low	Minimum	High
Manual thermostat setback	gas	0	44	27	21	.....	Immediate	.....
Automatic thermostat setback (owner installed)	gas	90	44	27	21	2	3	4
Automatic thermostat (contractor installed)	gas	130	44	27	21	3	4	5

TABLE B.51

ENERGY SAVINGS FROM THERMOSTAT SETBACK
EDMONTON - SEMI-DETACHED

Option	Fuel	Capital Cost ($1981)	Savings in First Year ($1981)			Payback Period (years)		
			Low	Minimum	High	Low	Minimum	High
Manual thermostat setback	gas	0	48	27	21	..... Immediate		
Automatic thermostat setback (owner installed)	gas	90	47	27	21	2	3	4
Automatic thermostat (contractor installed)	gas	130	47	27	21	3	4	5

TABLE B.52

ENERGY SAVINGS FROM THERMOSTAT SETBACK
REGINA - SEMI-DETACHED

Option	Fuel	Capital Cost ($1981)	Savings in First Year ($1981)			Payback Period (years)		
			Low	Minimum	High	Low	Minimum	High
Manual thermostat setback	oil	0	134	76	57	.....	Immediate	.....
	gas		52	30	21	.....	Immediate	.....
	electricity		106	59	45	.....	Immediate	.....
Automatic thermostat setback (owner installed)	oil	90	134	76	57	1	2	2
	gas		52	30	21	2	3	4
	electricity		106	59	45	1	2	2
Automatic thermostat (contractor installed)	oil	130	134	76	57	1	2	3
	gas		52	30	21	3	4	5
	electricity		106	59	45	2	3	3

TABLE B.53

ENERGY SAVINGS FROM THERMOSTAT SETBACK
WINNIPEG - SEMI-DETACHED

Option	Fuel	Capital Cost ($1981)	Savings in First Year ($1981)			Payback Period (years)		
			Low	Minimum	High	Low	Minimum	High
Manual thermostat setback	oil	0	134	77	56	..... Immediate		
	gas		64	38	26	..... Immediate		
	electricity		98	55	41	..... Immediate		
Automatic thermostat setback (owner installed)	oil	90	134	77	56	1	2	2
	gas		64	38	26	2	3	3
	electricity		98	55	41	1	2	3
Automatic thermostat (contractor installed)	oil	130	134	77	56	1	2	3
	gas		64	38	26	2	4	5
	electricity		98	55	41	2	3	4

TABLE B.54

ENERGY SAVINGS FROM THERMOSTAT SETBACK
TORONTO - SEMI-DETACHED

Option	Fuel	Capital Cost ($1981)	Savings in First Year ($1981)			Payback Period (years)		
			Low	Minimum	High	Low	Minimum	High
Manual thermostat setback	oil	0	95	55	41	.....	Immediate	.....
	gas		55	32	23	.....	Immediate	.....
	electricity		87	49	38	.....	Immediate	.....
Automatic thermostat setback (owner installed)	oil	90	95	55	41	1	2	3
	gas		55	32	23	2	3	4
	electricity		87	49	38	2	2	3
Automatic thermostat (contractor installed)	oil	130	95	55	41	2	3	4
	gas		55	32	23	3	4	6
	electricity		87	49	38	2	3	4

TABLE B.55

ENERGY SAVINGS FROM THERMOSTAT SETBACK
MONTREAL - SEMI-DETACHED

Option	Fuel	Capital Cost ($1981)	Savings in First Year ($1981)			Payback Period (years)		
			Low	Minimum	High	Low	Minimum	High
Manual thermostat setback	oil	0	103	60	45	.....	Immediate	.....
	gas		67	36	31	.....	Immediate	.....
	electricity		81	46	35	.....	Immediate	.....
Automatic thermostat setback (owner installed)	oil	90	103	60	45	1	2	2
	gas		67	36	31	2	3	3
	electricity		81	46	35	2	1	3
Automatic thermostat (contractor installed)	oil	130	103	60	45	2	3	3
	gas		67	36	31	2	4	4
	electricity		81	46	35	2	3	4

TABLE B.56

ENERGY SAVINGS FROM THERMOSTAT SETBACK
SAINT JOHN - SEMI-DETACHED

Option	Fuel	Capital Cost ($1981)	Savings in First Year ($1981)			Payback Period (years)		
			Low	Minimum	High	Low	Minimum	High
Manual thermostat setback	oil	0	111	65	48	.....	Immediate	.....
	gas		79	45	34	.....	Immediate	.....
	electricity		111	63	49	.....	Immediate	.....
Automatic thermostat setback (owner installed)	oil	90	111	65	48	1	2	2
	gas		79	45	34	2	2	3
	electricity		111	63	49	1	2	3
Automatic thermostat (contractor installed)	oil	130	111	65	48	2	2	3
	gas		79	45	34	2	3	4
	electricity		111	63	49	2	3	4

TABLE B.55

ENERGY SAVINGS FROM THERMOSTAT SETBACK
MONTREAL - SEMI-DETACHED

Option	Fuel	Capital Cost ($1981)	Savings in First Year ($1981)			Payback Period (years)		
			Low	Minimum	High	Low	Minimum	High
Manual thermostat setback	oil	0	103	60	45	.....	Immediate	.....
	gas		67	36	31	.....	Immediate	.....
	electricity		81	46	35	.....	Immediate	.....
Automatic thermostat setback (owner installed)	oil	90	103	60	45	1	2	2
	gas		67	36	31	2	3	3
	electricity		81	46	35	2	1	3
Automatic thermostat (contractor installed)	oil	130	103	60	45	2	3	3
	gas		67	36	31	2	4	4
	electricity		81	46	35	2	3	4

TABLE B.56

ENERGY SAVINGS FROM THERMOSTAT SETBACK
SAINT JOHN - SEMI-DETACHED

Option	Fuel	Capital Cost ($1981)	Savings in First Year ($1981)			Payback Period (years)		
			Low	Minimum	High	Low	Minimum	High
Manual thermostat setback	oil	0	111	65	48	.....	Immediate	.....
	gas		79	45	34	.....	Immediate	.....
	electricity		111	63	49	.....	Immediate	.....
Automatic thermostat setback (owner installed)	oil	90	111	65	48	1	2	2
	gas		79	45	34	2	2	3
	electricity		111	63	49	1	2	3
Automatic thermostat (contractor installed)	oil	130	111	65	48	2	2	3
	gas		79	45	34	2	3	4
	electricity		111	63	49	2	3	4

TABLE B.57

ENERGY SAVINGS FROM THERMOSTAT SETBACK
ST. JOHN'S - SEMI-DETACHED

Option	Fuel	Capital Cost ($1981)	Savings in First Year ($1981)			Payback Period (years)		
			Low	Minimum	High	Low	Minimum	High
Manual thermostat setback	oil	0	119	80	52	.....	Immediate	.....
	electricity		105	68	46	.....	Immediate	.....
Automatic thermostat setback (owner installed)	oil	90	119	80	52	1	2	2
	electricity		105	68	46	1	2	2
Automatic thermostat (contractor installed)	oil	130	119	80	52	2	2	3
	electricity		105	68	46	2	2	3

TABLE B.58

ENERGY SAVINGS FROM THERMOSTAT SETBACK
HALIFAX - SEMI-DETACHED

Option	Fuel	Capital Cost ($1981)	Savings in First Year ($1981)			Payback Period (years)		
			Low	Minimum	High	Low	Minimum	High
Manual thermostat setback	oil	0	95	63	42	.....	Immediate	.....
	electricity		128	83	56	.....	Immediate	.....
Automatic thermostat setback (owner installed)	oil	90	95	63	42	1	2	3
	electricity		128	83	56	1	2	2
Automatic thermostat (contractor installed)	oil	130	95	63	42	2	2	3
	electricity		128	83	56	2	2	3

TABLE B.59

ENERGY SAVINGS FROM THERMOSTAT SETBACK
VICTORIA - ROWHOUSE

Option	Fuel	Capital Cost ($1981)	Savings in First Year ($1981)			Payback Period (years)		
			Low	Minimum	High	Low	Minimum	High
Manual thermostat setback	oil	0	57	40	27	.....	Immediate	.....
	electricity		50	34	23	.....	Immediate	.....
Automatic thermostat setback (owner installed)	oil	90	57	40	27	2	3	4
	electricity		50	34	23	2	3	4
Automatic thermostat (contractor installed)	oil	130	57	40	27	3	4	5
	electricity		50	34	23	3	4	6

TABLE B.60

ENERGY SAVINGS FROM THERMOSTAT SETBACK
VANCOUVER - ROWHOUSE

Option	Fuel	Capital Cost ($1981)	Savings in First Year ($1981)			Payback Period (years)		
			Low	Minimum	High	Low	Minimum	High
Manual thermostat setback	oil	0	56	39	26	.....	Immediate	.....
	gas		24	17	10	.....	Immediate	.....
	electricity		49	33	23	.....	Immediate	.....
Automatic thermostat setback (owner installed)	oil	90	56	39	26	2	3	4
	gas		24	17	10	4	5	8
	electricity		49	33	23	2	3	5
Automatic thermostat (contractor installed)	oil	130	56	39	26	3	4	6
	gas		24	17	10	5	7	>10
	electricity		49	33	23	3	5	6

TABLE B.61

ENERGY SAVINGS FROM THERMOSTAT SETBACK
CALGARY - ROWHOUSE

Option	Fuel	Capital Cost ($1981)	Savings in First Year ($1981)			Payback Period (years)		
			Low	Minimum	High	Low	Minimum	High
Manual thermostat setback	gas	0	35	21	15	.....	Immediate	.....
Automatic thermostat setback (owner installed)	gas	90	35	21	15	3	4	5
Automatic thermostat (contractor installed)	gas	130	35	21	15	3	5	7

TABLE B.62

ENERGY SAVINGS FROM THERMOSTAT SETBACK
EDMONTON - ROWHOUSE

Option	Fuel	Capital Cost ($1981)	Savings in First Year ($1981)			Payback Period (years)		
			Low	Minimum	High	Low	Minimum	High
Manual thermostat setback	gas	0	38	21	15	..... Immediate		
Automatic thermostat setback (owner installed)	gas	90	38	21	15	2	4	5
Automatic thermostat (contractor installed)	gas	130	38	21	15	3	5	7

TABLE B.63

ENERGY SAVINGS FROM THERMOSTAT SETBACK
REGINA - ROWHOUSE

Option	Fuel	Capital Cost ($1981)	Savings in First Year ($1981)			Payback Period (years)		
			Low	Minimum	High	Low	Minimum	High
Manual thermostat setback	oil	0	107	62	46	.....	Immediate	.....
	gas		43	24	18	.....	Immediate	.....
	electricity		85	48	37	.....	Immediate	.....
Automatic thermostat setback (owner installed)	oil	90	107	62	46	1	2	2
	gas		43	24	18	2	3	4
	electricity		85	48	37	2	2	3
Automatic thermostat (contractor installed)	oil	130	107	62	46	2	3	3
	gas		43	24	18	3	5	6
	electricity		85	48	37	2	3	4

TABLE B.64

ENERGY SAVINGS FROM THERMOSTAT SETBACK
WINNIPEG - ROWHOUSE

Option	Fuel	Capital Cost ($1981)	Savings in First Year ($1981)			Payback Period (years)		
			Low	Minimum	High	Low	Minimum	High
Manual thermostat setback	oil	0	108	63	46	..... Immediate		
	gas		53	30	23	..... Immediate		
	electricity		79	44	34	..... Immediate		
Automatic thermostat setback (owner installed)	oil	90	108	63	46	1	2	2
	gas		53	30	23	2	3	4
	electricity		79	44	34	2	3	4
Automatic thermostat (contractor installed)	oil	130	108	63	46	2	3	3
	gas		53	30	23	3	4	6
	electricity		79	44	34	2	4	5

TABLE B.65

ENERGY SAVINGS FROM THERMOSTAT SETBACK
TORONTO - ROWHOUSE

Option	Fuel	Capital Cost ($1981)	Savings in First Year ($1981)			Payback Period (years)		
			Low	Minimum	High	Low	Minimum	High
Manual thermostat setback	oil	0	76	45	34	.....	Immediate	.....
	gas		41	28	18	.....	Immediate	.....
	electricity		70	40	31	.....	Immediate	.....
Automatic thermostat setback (owner installed)	oil	90	76	45	34	2	2	3
	gas		41	28	18	3	4	5
	electricity		70	40	31	2	3	4
Automatic thermostat (contractor installed)	oil	130	76	45	34	2	3	4
	gas		41	28	18	4	5	8
	electricity		70	40	31	2	4	5

TABLE B.66

ENERGY SAVINGS FROM THERMOSTAT SETBACK
MONTREAL - ROWHOUSE

Option	Fuel	Capital Cost ($1981)	Savings in First Year ($1981)			Payback Period (years)		
			Low	Minimum	High	Low	Minimum	High
Manual thermostat setback	oil	0	82	49	36	.....	Immediate	.....
	gas		51	31	26	.....	Immediate	.....
	electricity		65	37	29	.....	Immediate	.....
Automatic thermostat setback (owner installed)	oil	90	82	49	36	2	2	3
	gas		51	31	26	2	3	4
	electricity		65	37	29	2	3	4
Automatic thermostat (contractor installed)	oil	130	82	49	36	2	3	4
	gas		51	31	26	3	4	5
	electricity		65	37	29	2	4	5

TABLE B.67

ENERGY SAVINGS FROM THERMOSTAT SETBACK
SAINT JOHN - ROWHOUSE

Option	Fuel	Capital Cost ($1981)	Savings in First Year ($1981)			Payback Period (years)		
			Low	Minimum	High	Low	Minimum	High
Manual thermostat setback	oil	0	88	53	39	.....	Immediate	.....
	gas		62	39	28	.....	Immediate	.....
	electricity		89	51	40	.....	Immediate	.....
Automatic thermostat setback (owner installed)	oil	90	88	53	39	2	2	3
	gas		62	39	28	2	3	4
	electricity		89	51	40	2	2	3
Automatic thermostat (contractor installed)	oil	130	88	53	39	2	3	4
	gas		62	39	28	3	4	5
	electricity		89	51	40	2	3	4

TABLE B.68

ENERGY SAVINGS FROM THERMOSTAT SETBACK
ST. JOHN'S - ROWHOUSE

Option	Fuel	Capital Cost ($1981)	Savings in First Year ($1981)			Payback Period (years)		
			Low	Minimum	High	Low	Minimum	High
Manual thermostat setback	oil	0	95	67	42	..... Immediate		
	electricity		84	57	37	..... Immediate		
Automatic thermostat setback (owner installed)	oil	90	95	67	42	1	2	3
	electricity		84	57	37	2	2	3
Automatic thermostat (contractor installed)	oil	130	95	67	42	2	2	4
	electricity		84	57	37	2	3	4

TABLE B.67

ENERGY SAVINGS FROM THERMOSTAT SETBACK
SAINT JOHN - ROWHOUSE

Option	Fuel	Capital Cost ($1981)	Savings in First Year ($1981)			Payback Period (years)		
			Low	Minimum	High	Low	Minimum	High
Manual thermostat setback	oil	0	88	53	39	.....	Immediate	.....
	gas		62	39	28	.....	Immediate	.....
	electricity		89	51	40	.....	Immediate	.....
Automatic thermostat setback (owner installed)	oil	90	88	53	39	2	2	3
	gas		62	39	28	2	3	4
	electricity		89	51	40	2	2	3
Automatic thermostat (contractor installed)	oil	130	88	53	39	2	3	4
	gas		62	39	28	3	4	5
	electricity		89	51	40	2	3	4

TABLE B.68

ENERGY SAVINGS FROM THERMOSTAT SETBACK
ST. JOHN'S - ROWHOUSE

Option	Fuel	Capital Cost ($1981)	Savings in First Year ($1981)			Payback Period (years)		
			Low	Minimum	High	Low	Minimum	High
Manual thermostat setback	oil	0	95	67	42	.....	Immediate	.....
	electricity		84	57	37	.....	Immediate	.....
Automatic thermostat setback (owner installed)	oil	90	95	67	42	1	2	3
	electricity		84	57	37	2	2	3
Automatic thermostat (contractor installed)	oil	130	95	67	42	2	2	4
	electricity		84	57	37	2	3	4

TABLE B.69

ENERGY SAVINGS FROM THERMOSTAT SETBACK
HALIFAX - ROWHOUSE

Option	Fuel	Capital Cost ($1981)	Savings in First Year ($1981)			Payback Period (years)		
			Low	Minimum	High	Low	Minimum	High
Manual thermostat setback	oil	0	77	53	33	.....	Immediate	.....
	electricity		103	70	46	.....	Immediate	.....
Automatic thermostat setback (owner installed)	oil	90	77	53	33	2	2	3
	electricity		103	70	46	1	2	3
Automatic thermostat (contractor installed)	oil	130	77	53	33	2	3	4
	electricity		103	70	46	2	2	4

APPENDIX C

CONSERVATION MEASURES — DOMESTIC HOT WATER HEATING

TABLE C.1

CONSERVATION MEASURES - DOMESTIC HOT WATER HEATING
VICTORIA

Option	Fuel	Capital Cost ($1981)	Savings in First Year ($1981)	Payback Period (years)
Manual thermostat setback	oil	0	31	Immed.
	electricity		25	Immed.
Shower:				
Flow restrictor	oil	3-4	29	1
	electricity		26	1
Adjustable Volume Control	oil	8-12	29	1
	electricity		26	1
Faucet:				
Flow restrictor	oil	1-3	10	1
	electricity		9	1
Aerator	oil	5-7	10	1
	electricity		9	1
Spray Tap	oil	8-10	10	1
	electricity		9	1

NOTE: Assumes most likely price scenario.

TABLE C.2

CONSERVATION MEASURES - DOMESTIC HOT WATER HEATING
VANCOUVER

Option	Fuel	Capital Cost ($1981)	Savings in First Year ($1981)	Payback Period (years)
Manual thermostat setback	oil	0	31	Immed.
	gas		14	
	electricity		25	
Shower:	oil	3-4	29	1
Flow restrictor	gas		13	1
	electricity		26	1
Adjustable Volume Control	oil	8-12	29	1
	gas		13	1
	electricity		26	1
Faucet:				
Flow restrictor	oil	1-3	10	1
	gas		4	1
	electricity		9	1
Aerator	oil	5-7	10	1
	gas		4	1
	electricity		9	1
Spray Tap	oil	8-10	10	1
	gas		4	2-3
	electricity		9	1

NOTE: Assumes most likely price scenario.

TABLE C.3

CONSERVATION MEASURES - DOMESTIC HOT WATER HEATING
CALGARY

Option	Fuel	Capital Cost ($1981)	Savings in First Year ($1981)	Payback Period (years)
Manual thermostat setback	oil	0	30	Immed.
	gas		12	Immed.
	electricity		23	Immed.
Shower:				
Flow restrictor	oil	3-4	28	1
	gas		11	1
	electricity		24	1
Adjustable Volume Control	oil	8-12	28	1
	gas		11	1
	electricity		24	1
Faucet:				
Flow restrictor	oil	1-3	10	1
	gas		4	1
	electricity		8	1
Aerator	oil	5-7	10	1
	gas		4	2
	electricity		8	1
Spray Tap	oil	8-10	10	1
	gas		4	2-3
	electricity		8	1

NOTE: Assumes most likely price scenario.

TABLE C.4

CONSERVATION MEASURES - DOMESTIC HOT WATER HEATING
EDMONTON

Option	Fuel	Capital Cost ($1981)	Savings in First Year ($1981)	Payback Period (years)
Manual thermostat setback	oil	0	30	Immed.
	gas		12	Immed.
	electricity		23	Immed.
Shower:				
Flow restrictor	oil	3-4	28	1
	gas		11	1
	electricity		24	1
Adjustable Volume Control	oil	8-12	28	1
	gas		11	1
	electricity		24	1
Faucet:				
Flow restrictor	oil	1-3	10	1
	gas		4	1
	electricity		8	1
Aerator	oil	5-7	10	1
	gas		4	2
	electricity		8	1
Spray Tap	oil	8-10	10	1
	gas		4	2-3
	electricity		8	1

NOTE: Assumes most likely price scenario.

TABLE C.5

CONSERVATION MEASURES - DOMESTIC HOT WATER HEATING
REGINA

Option	Fuel	Capital Cost ($1981)	Savings in First Year ($1981)	Payback Period (years)
Manual thermostat setback	oil	0	30	Immed.
	gas		13	Immed.
	electricity		22	Immed.
Shower:	oil	3-4	28	1
Flow restrictor	gas		11	1
	electricity		23	1
Adjustable Volume Control	oil	8-12	28	1
	gas		11	1
	electricity		23	
Faucet:				
Flow restrictor	oil	1-3	10	1
	gas		4	1
	electricity		8	1
Aerator	oil	5-7	10	1
	gas		4	2
	electricity		8	1
Spray Tap	oil	8-10	10	1
	gas		4	2-3
	electricity		8	1-2

NOTE: Assumes most likely price scenario.

TABLE C.6

CONSERVATION MEASURES - DOMESTIC HOT WATER HEATING
WINNIPEG

Option	Fuel	Capital Cost ($1981)	Savings in First Year ($1981)	Payback Period (years)
Manual thermostat setback	oil	0	30	Immed.
	gas		16	Immed.
	electricity		20	Immed.
Shower:				
Flow restrictor	oil	3-4	29	1
	gas		14	1
	electricity		21	1
Adjustable Volume Control	oil	8-12	29	1
	gas		14	1
	electricity		21	1
Faucet:				
Flow restrictor	oil	1-3	10	1
	gas		5	1
	electricity		7	1
Aerator	oil	5-7	10	1
	gas		5	1-2
	electricity		7	1
Spray Tap	oil	8-10	10	1
	gas		5	2
	electricity		7	2

NOTE: Assumes most likely price scenario.

TABLE C.7

CONSERVATION MEASURES - DOMESTIC HOT WATER HEATING
TORONTO

Option	Fuel	Capital Cost ($1981)	Savings in First Year ($1981)	Payback Period (years)
Manual thermostat setback	oil	0	31	Immed.
	gas		19	Immed.
	electricity		26	Immed.
Shower:	oil	3-4	29	1
Flow restrictor	gas		17	1
	electricity		27	1
Adjustable Volume Control	oil	8-12	29	1
	gas		17	1
	electricity		27	1
Faucet:				
Flow restrictor	oil	1-3	10	1
	gas		6	1
	electricity		9	1
Aerator	oil	5-7	10	1
	gas		6	1-2
	electricity		9	1
Spray Tap	oil	8-10	10	1
	gas		6	2
	electricity		9	1-2

NOTE: Assumes most likely price scenario.

TABLE C.8

CONSERVATION MEASURES - DOMESTIC HOT WATER HEATING
MONTREAL

Option	Fuel	Capital Cost ($1981)	Savings in First Year ($1981)	Payback Period (years)
Manual thermostat setback	oil	0	31	Immed.
	gas		21	Immed.
	electricity		22	Immed.
Shower:				
Flow restrictor	oil	3-4	29	1
	gas		18	1
	electricity		23	1
Adjustable Volume Control	oil	8-12	29	1
	gas		18	1
	electricity		23	1
Faucet:				
Flow restrictor	oil	1-3	10	1
	gas		6	1
	electricity		8	1
Aerator	oil	5-7	10	1
	gas		6	1-2
	electricity		8	1
Spray Tap	oil	8-10	10	1
	gas		6	2
	electricity		8	1-2

NOTE: Assumes most likely price scenario.

TABLE C.9

CONSERVATION MEASURES - DOMESTIC HOT WATER HEATING
SAINT JOHN

Option	Fuel	Capital Cost ($1981)	Savings in First Year ($1981)	Payback Period (years)
Manual thermostat setback	oil	0	31	Immed.
	electricity		28	Immed.
Shower:				
Flow restrictor	oil	3-4	29	1
	electricity		29	1
Adjustable Volume Control	oil	8-12	29	1
	electricity		29	1
			29	1
Faucet:				
Flow restrictor	oil	1-3	10	1
	electricity		10	1
Aerator	oil	5-7	10	1
	electricity		10	1
Spray Tap	oil	8-10	10	1
	electricity		10	1

NOTE: Assumes most likely price scenario.

TABLE C.10

CONSERVATION MEASURES - DOMESTIC HOT WATER HEATING
ST. JOHN'S

Option	Fuel	Capital Cost ($1981)	Savings in First Year ($1981)	Payback Period (years)
Manual thermostat setback	oil	0	33	Immed.
	electricity		27	Immed.
Shower:				
Flow restrictor	oil	3-4	31	1
	electricity		28	1
Adjustable Volume Control	oil	8-12	31	1
	electricity		28	1
Faucet:				
Flow restrictor	oil	1-3	11	1
	electricity		9	1
Aerator	oil	5-7	11	1
	electricity		9	1
Spray Tap	oil	8-10	11	1
	electricity		9	1-2

NOTE: Assumes most likely price scenario.

TABLE C.11

CONSERVATION MEASURES - DOMESTIC HOT WATER HEATING
HALIFAX

Option	Fuel	Capital Cost ($1981)	Savings in First Year ($1981)	Payback Period (years)
Manual thermostat setback	oil	0	31	Immed.
	electricity		38	Immed.
Shower:				
Flow restrictor	oil	3-4	29	1
	electricity		39	1
Adjustable Volume Control	oil	8-12	29	1
	electricity		39	1
Faucet:				
Flow restrictor	oil	1-3	10	1
	electricity		13	1
Aerator	oil	5-7	10	1
	electricity		13	1
Spray Tap	oil	8-10	10	1
	electricity		13	1

NOTE: Assumes most likely price scenario.

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